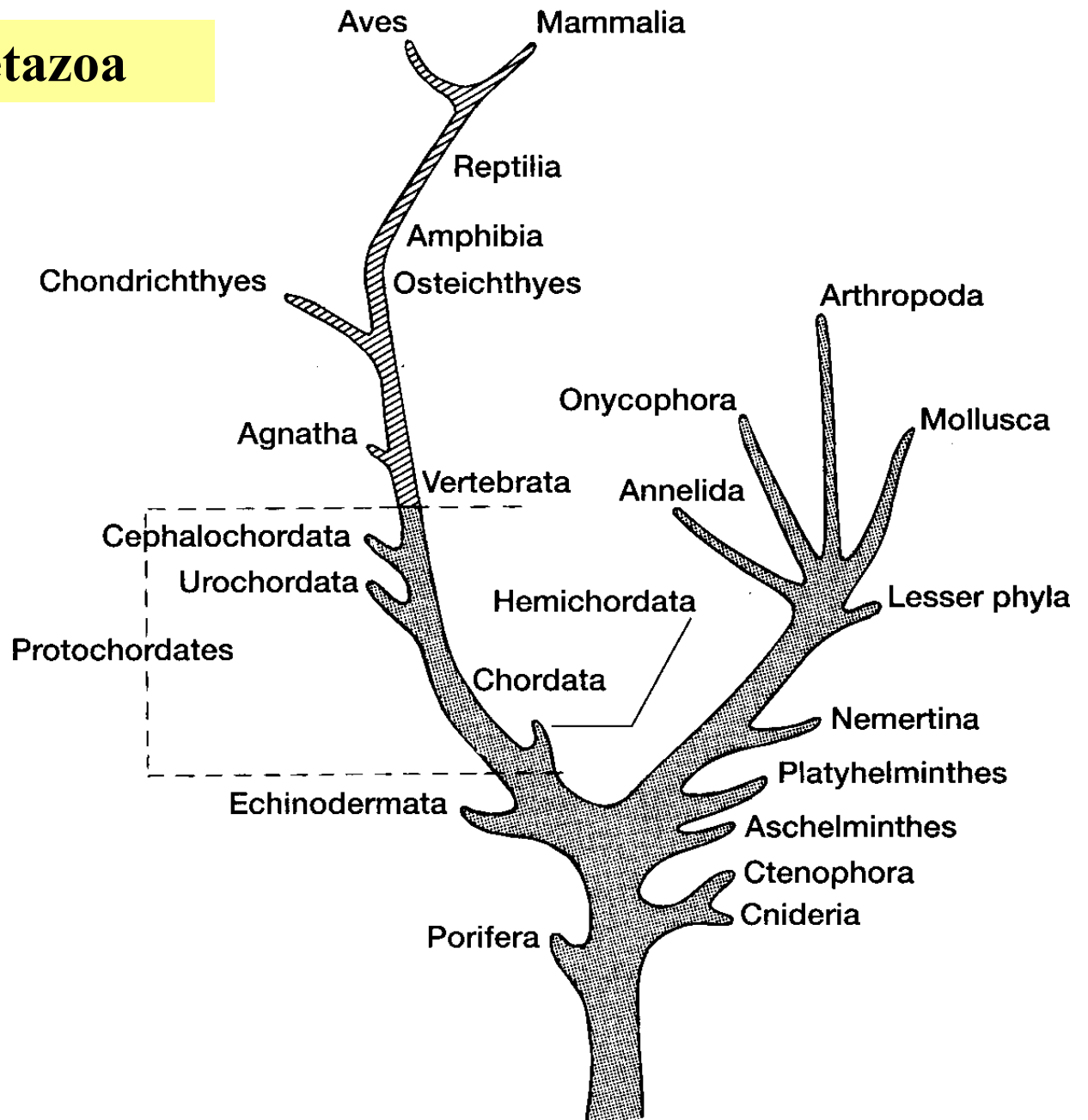
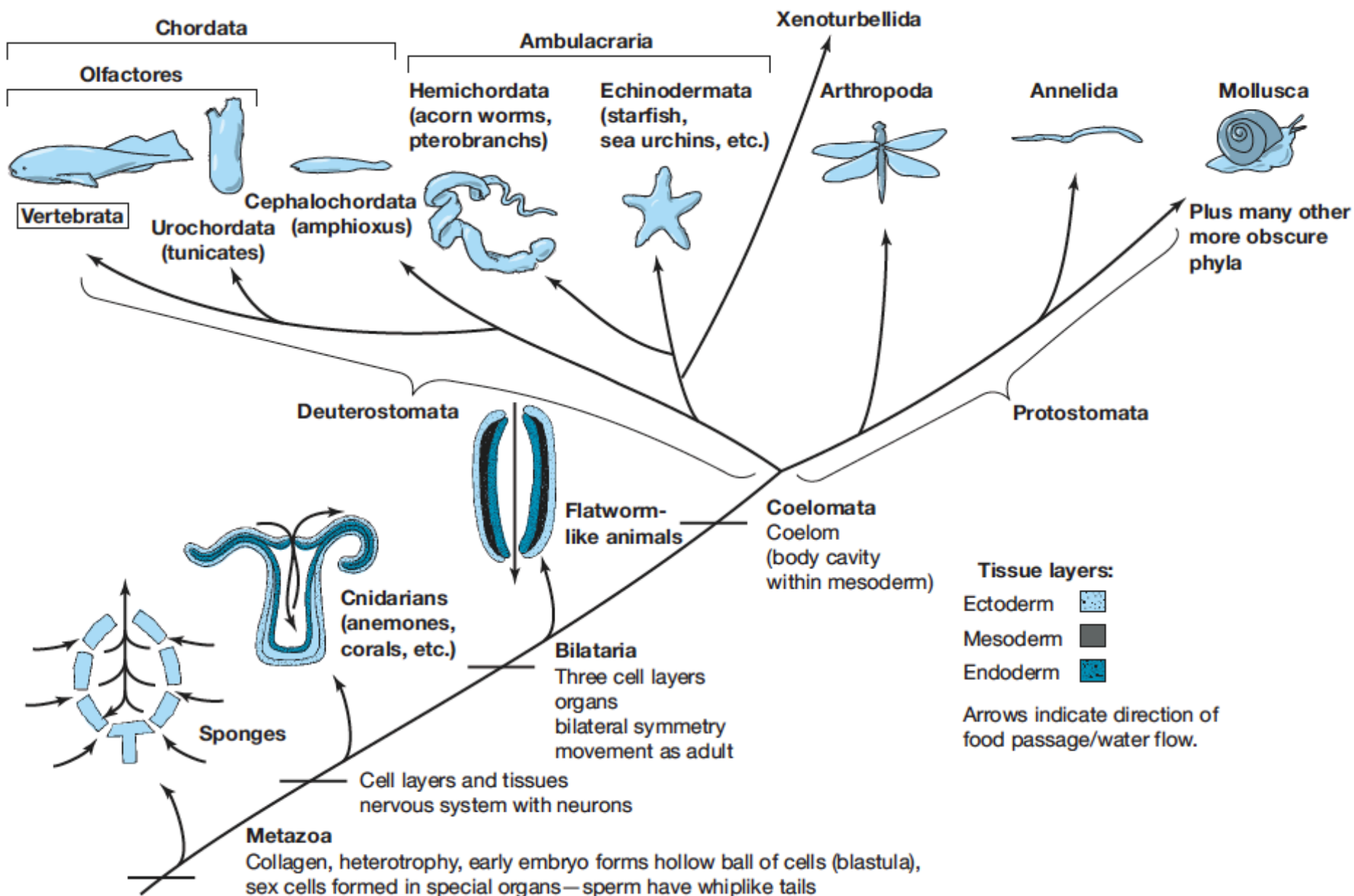


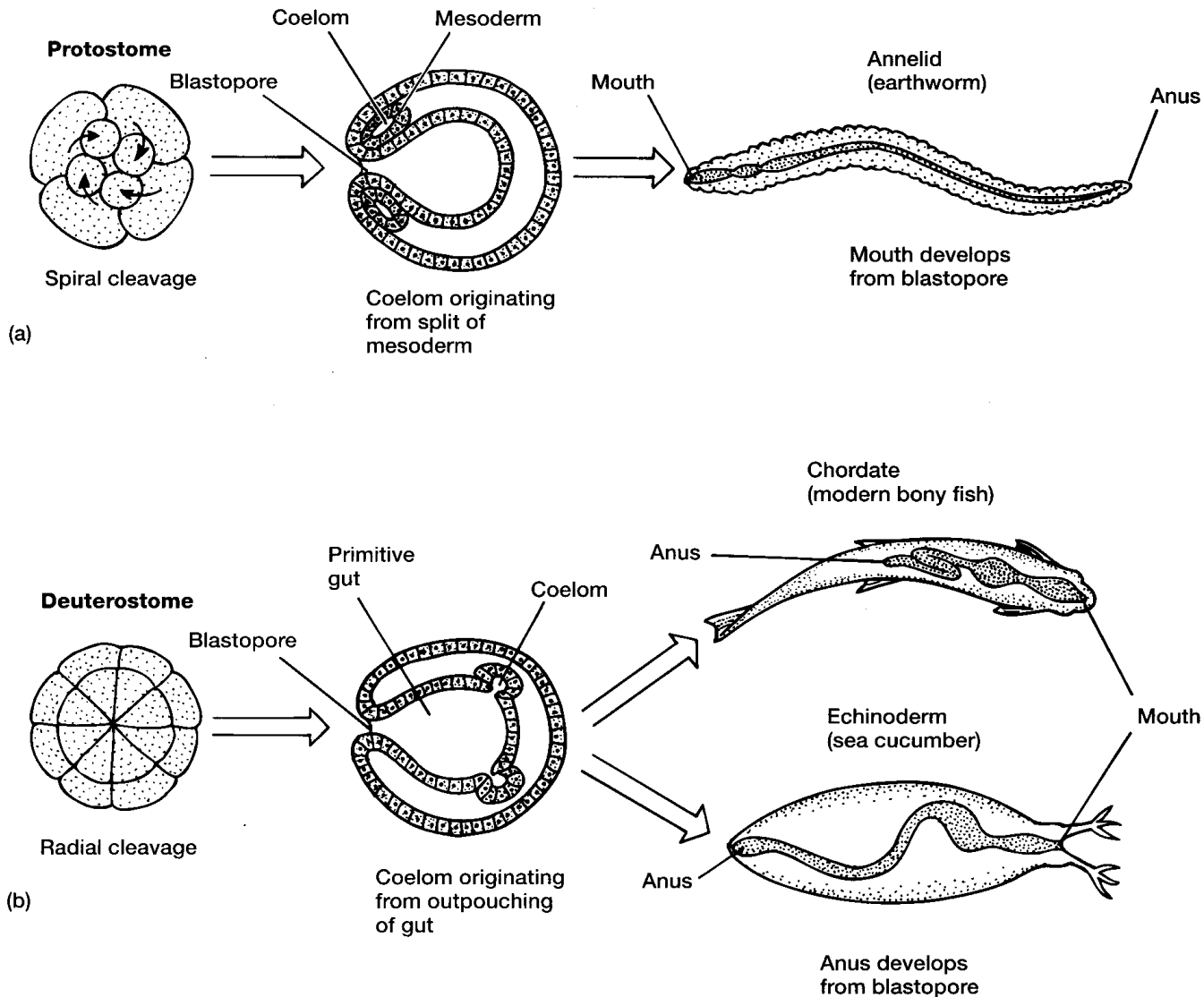
Origem dos Cordados
Urochordata
Cephalochordata

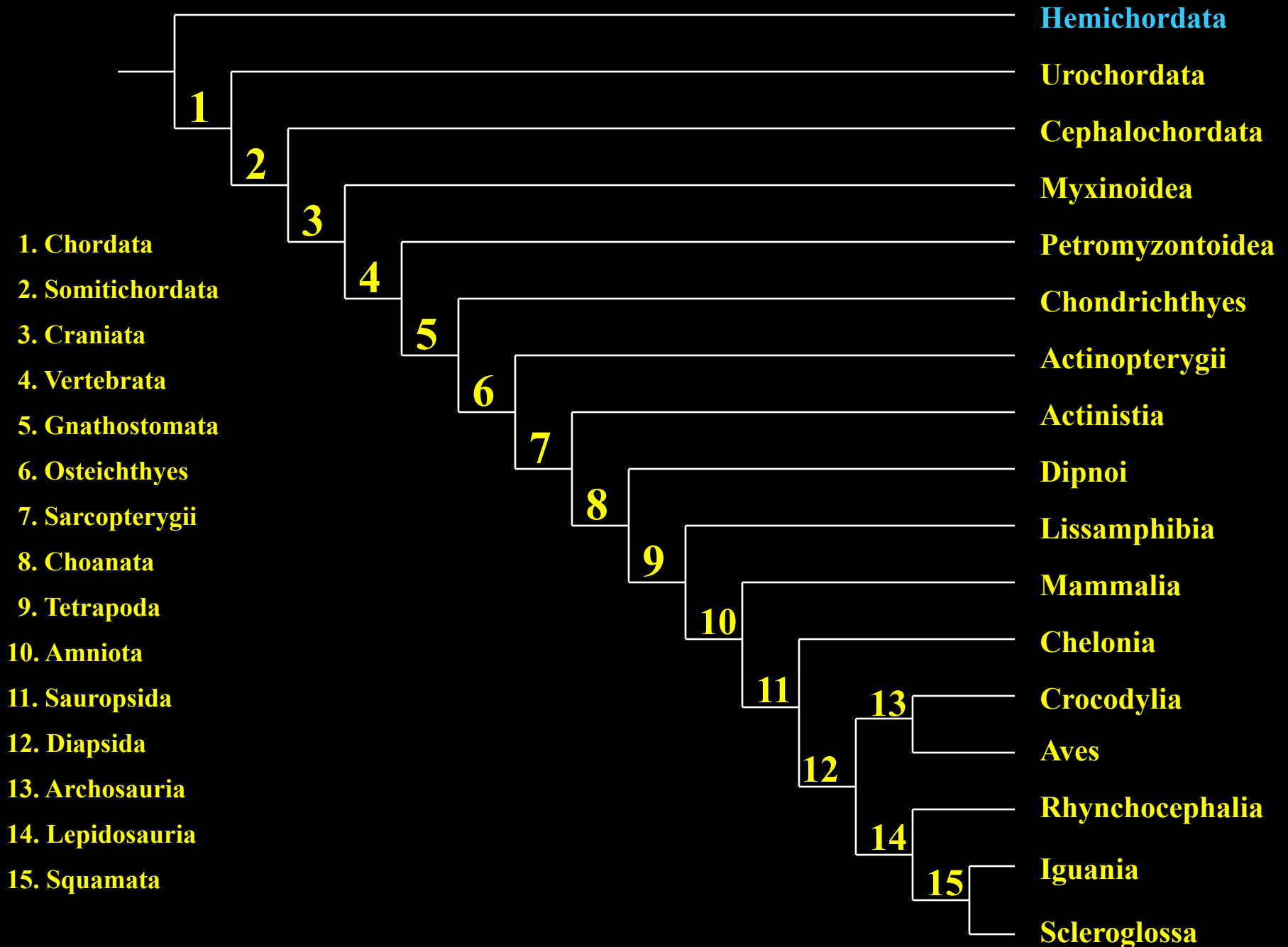
Filogenia de Metazoa

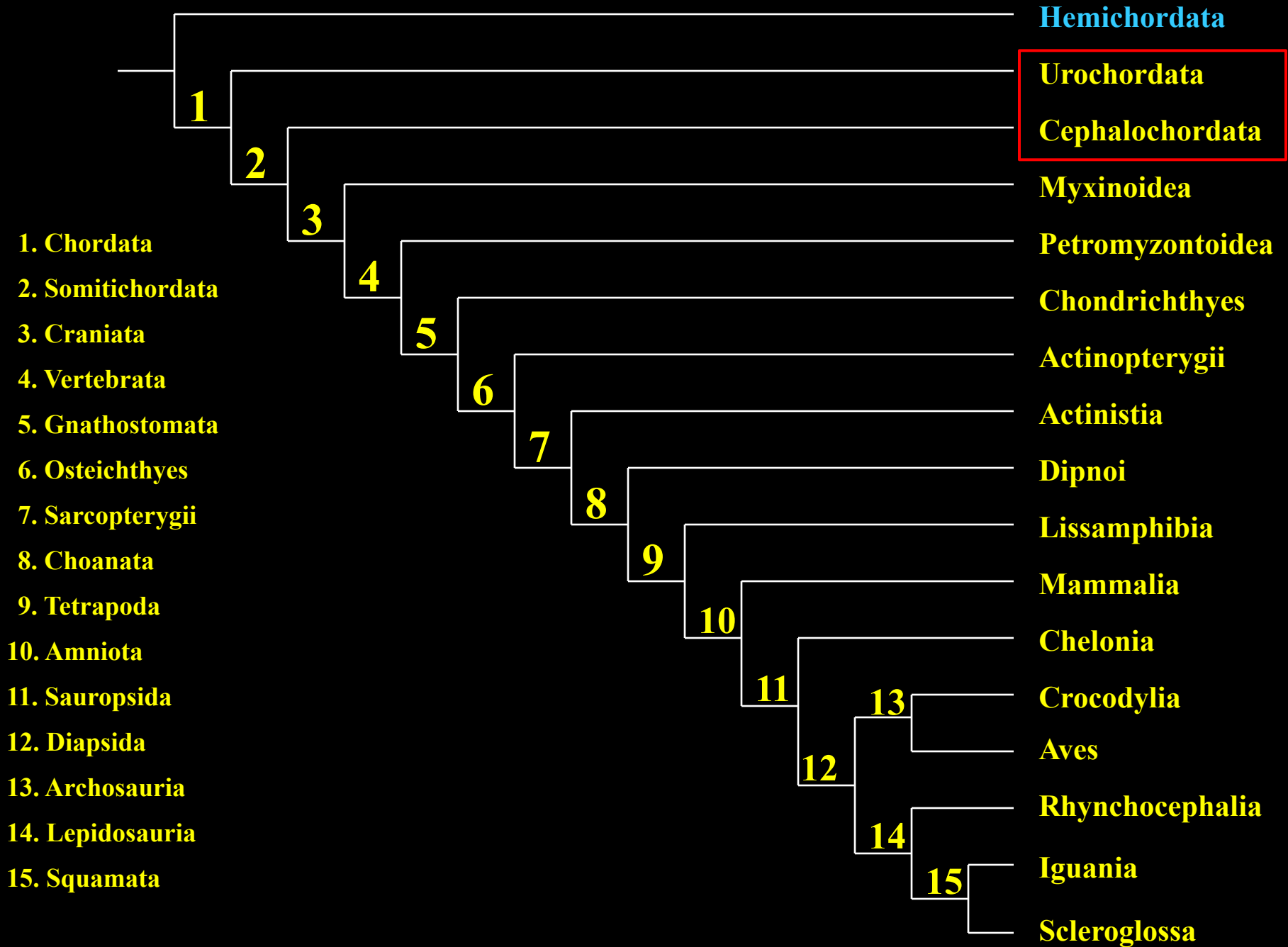




Protostômios e Deuterostômios







Hemichordata

Urochordata

Cephalochordata

Craniata

probóscibe, colar e tronco
estomocorda

órgão da roda
tentáculos do velo

predadores
livre-natantes
pedomorfose

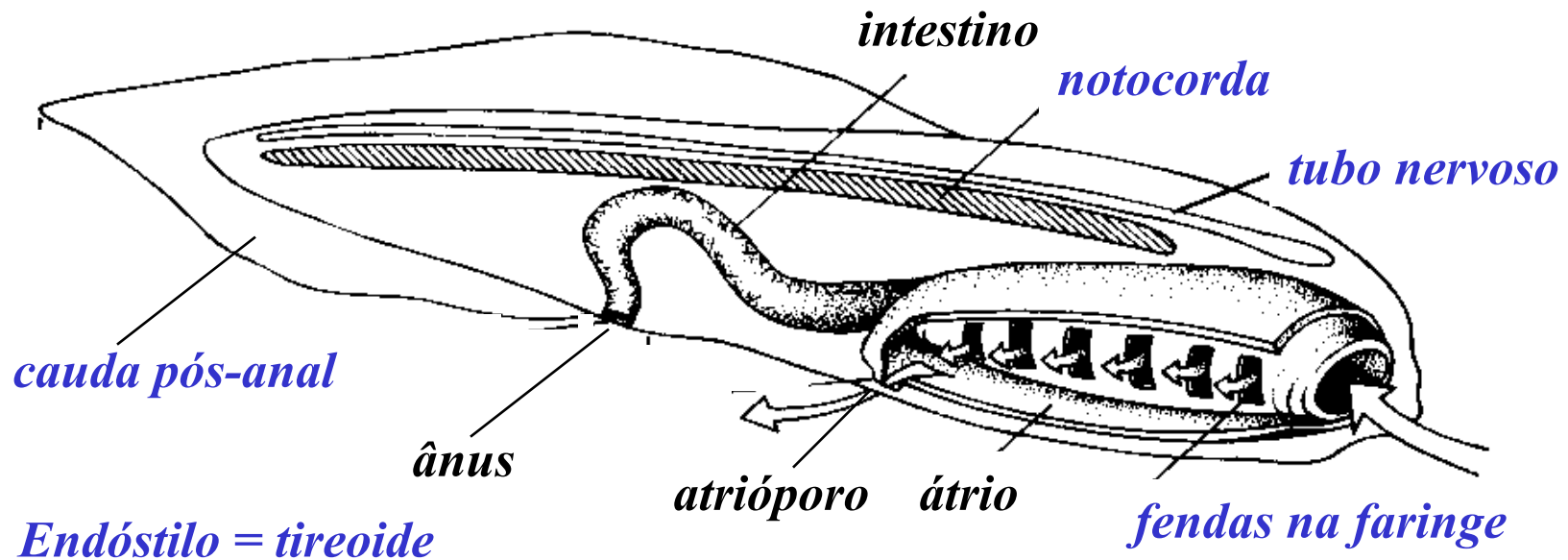
túnica

cordão nervoso em todo o corpo
notocorda em todo o corpo
cauda segmentada
ceco digestivo (= fígado)
sistema circulatório com aortas
substâncias branca e cinzenta

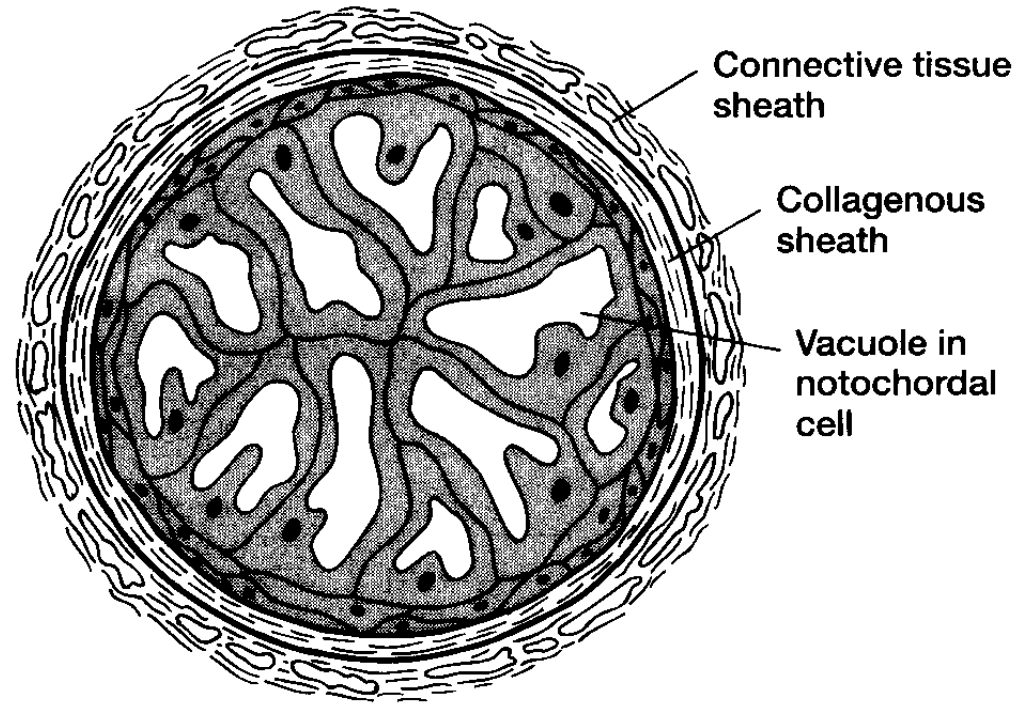
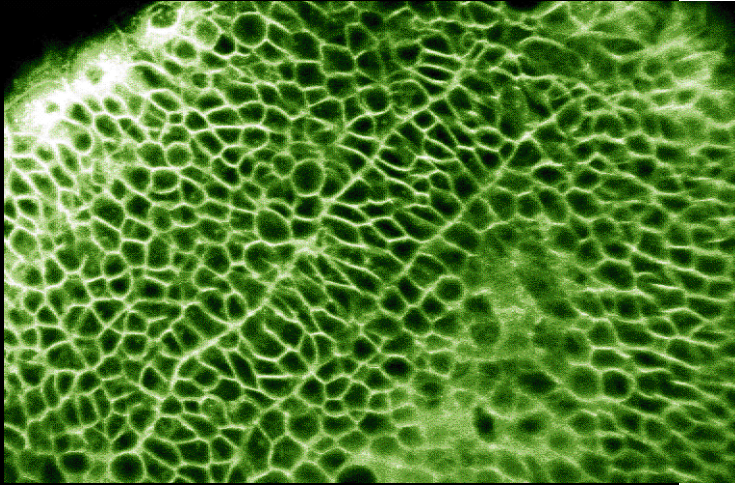
cordão nervoso na cauda da larva
notocorda na cauda da larva
cauda muscular pós-anal
endóstilo (= tireóide)

fendas na
faringe

Sinapomorfias para Chordata



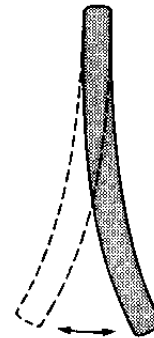
Notocorda



(a)

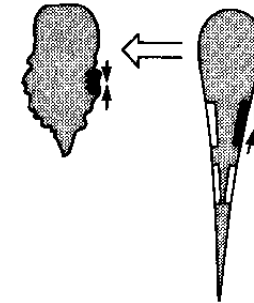


(b)



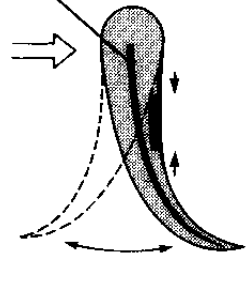
(c)

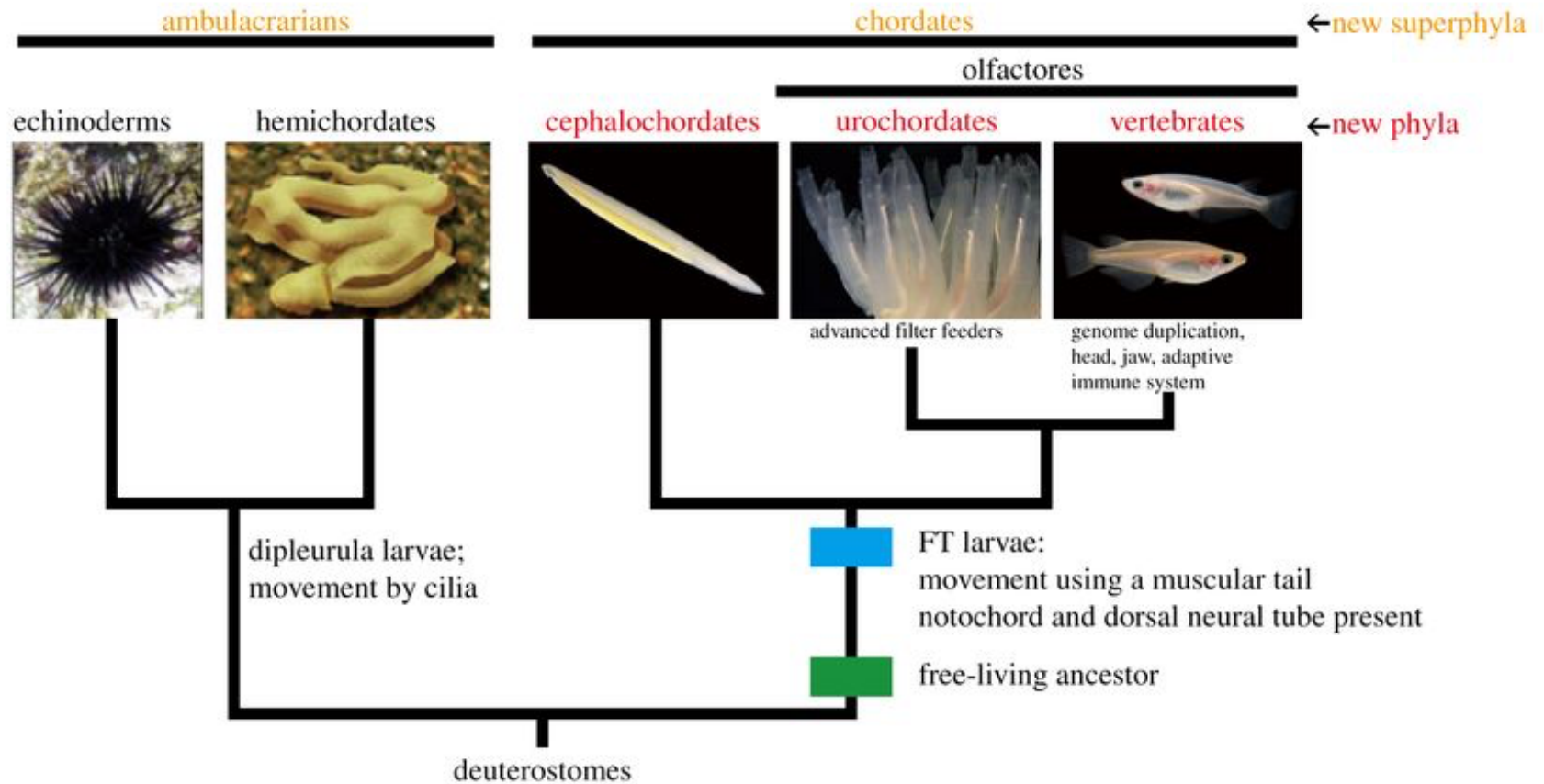
Without notochord



(d)

With notochord

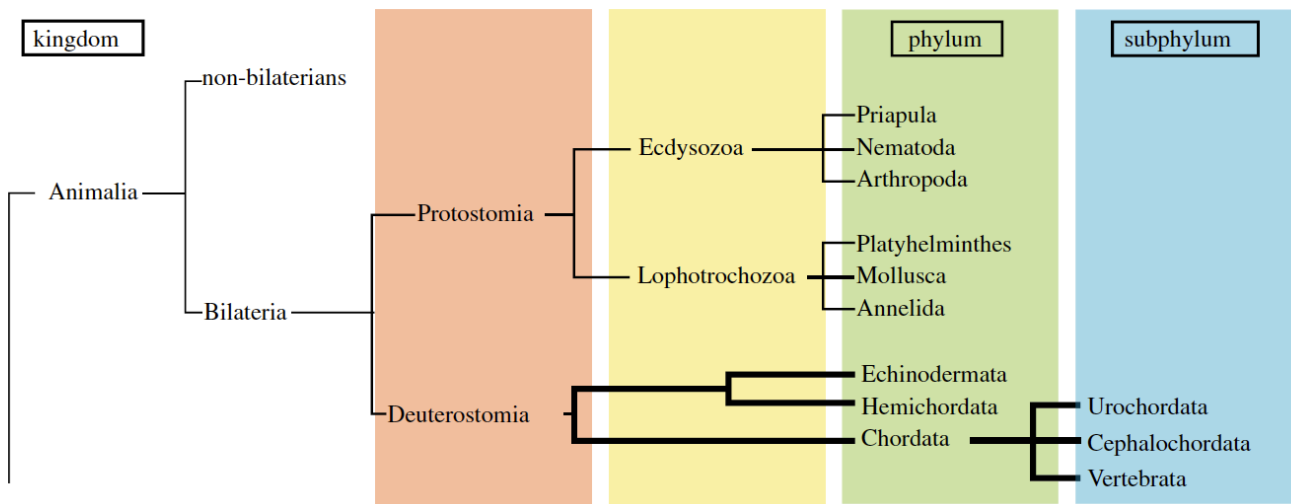




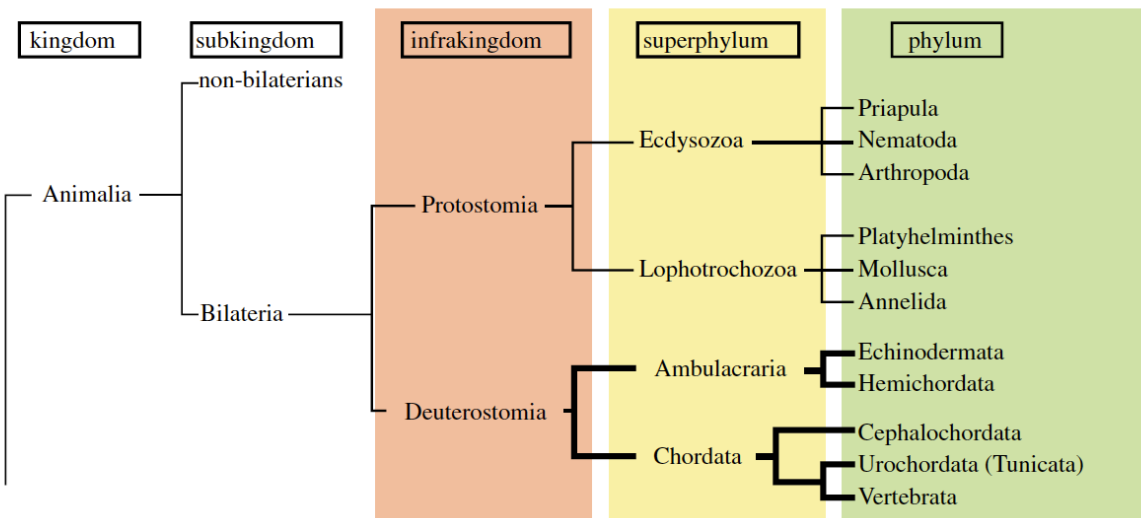
Chordate evolution and the three-phylum system

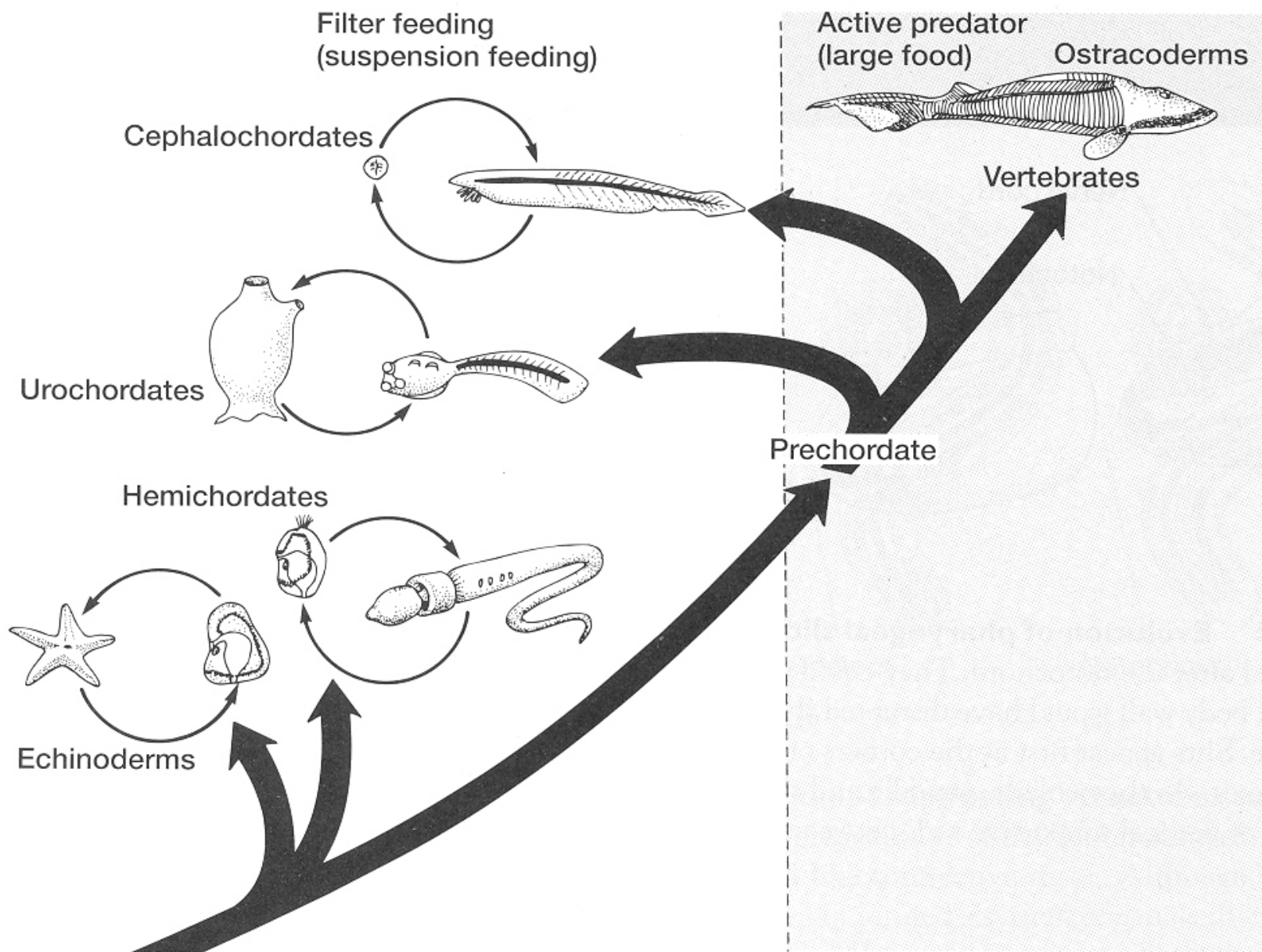
Noriyuki Satoh¹, Daniel Rokhsar² and Teruaki Nishikawa³

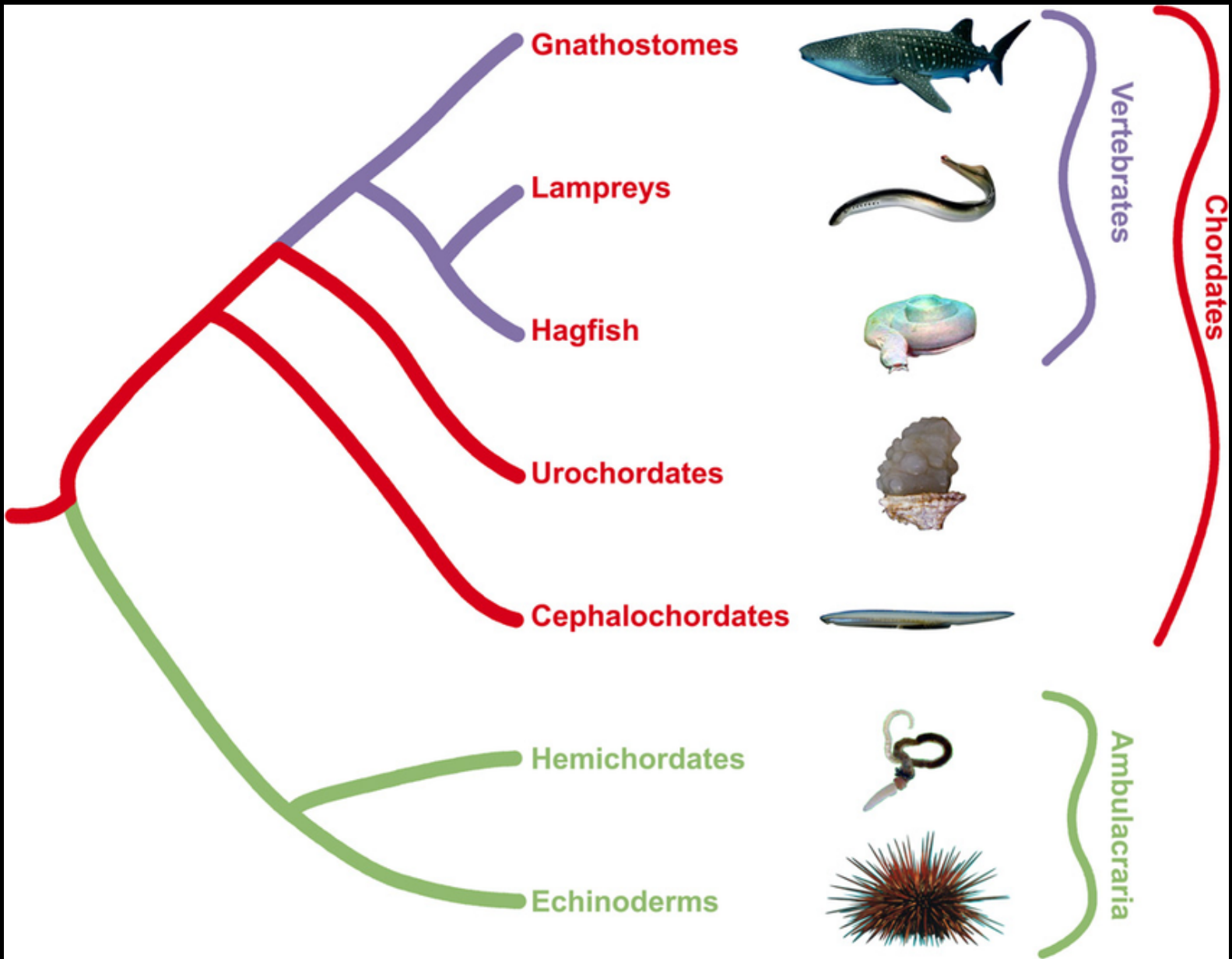
(b) current view

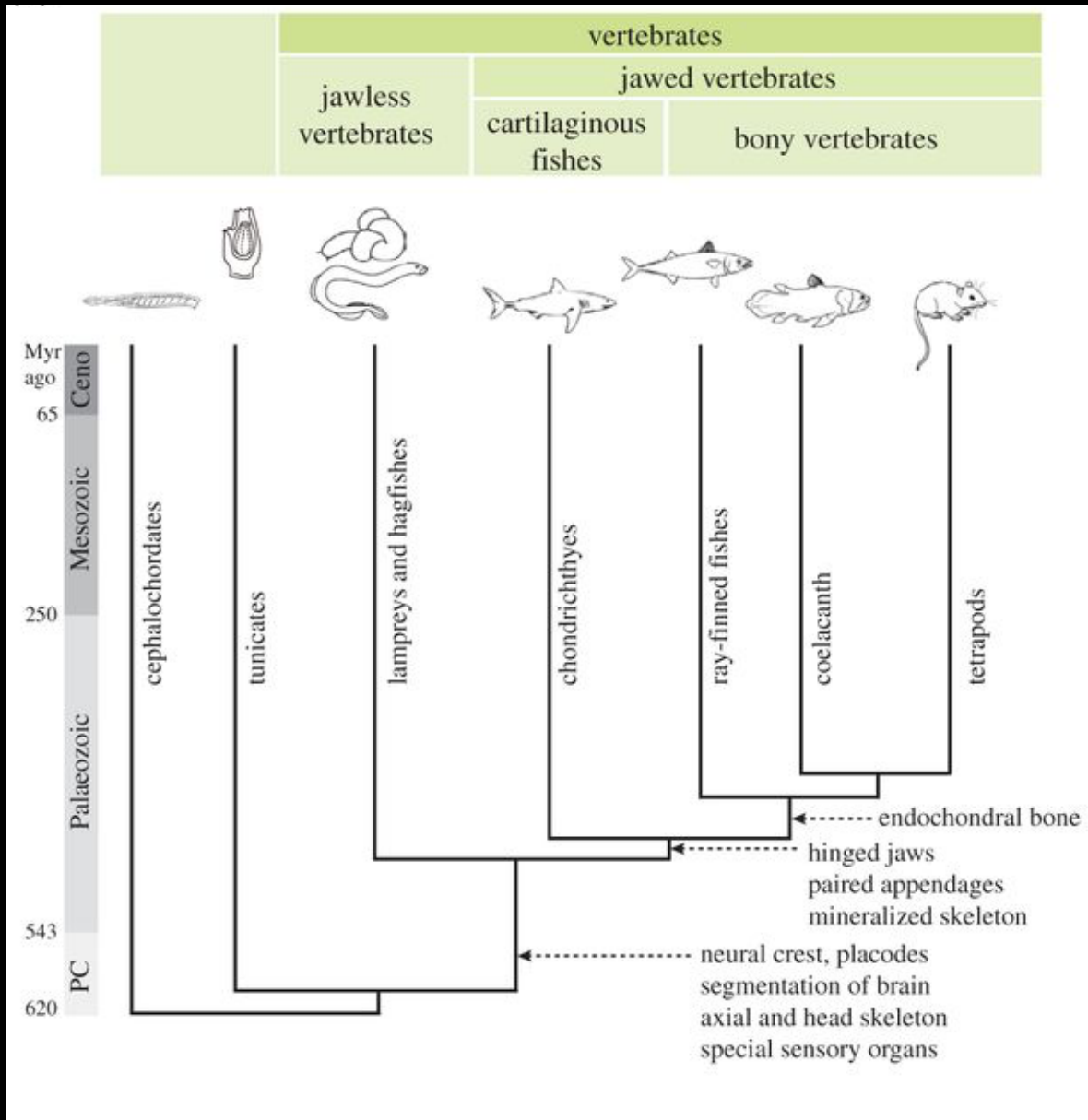


(c) a proposed view









Lampreys and hagfishes (cyclostomes) lack mineralized tissues

Cartilaginous fishes produce extensive dermal bone, such as teeth, dermal denticle and fin spine.

However, they lack the ability to make endochondral bone, which is unique to bony vertebrates.

CEPHALOCHORDATA

(anfioxos)



Branchiostoma: refere-se (erroneamente) aos cirros orais

45 espécies marinhas bentônicas de águas rasas

Descritos como moluscos em 1744

Visto como um intermediário evolutivo entre invertebrados e vertebrados

Consumidos na Ásia (30 toneladas por ano, 1 bilhão de indivíduos)

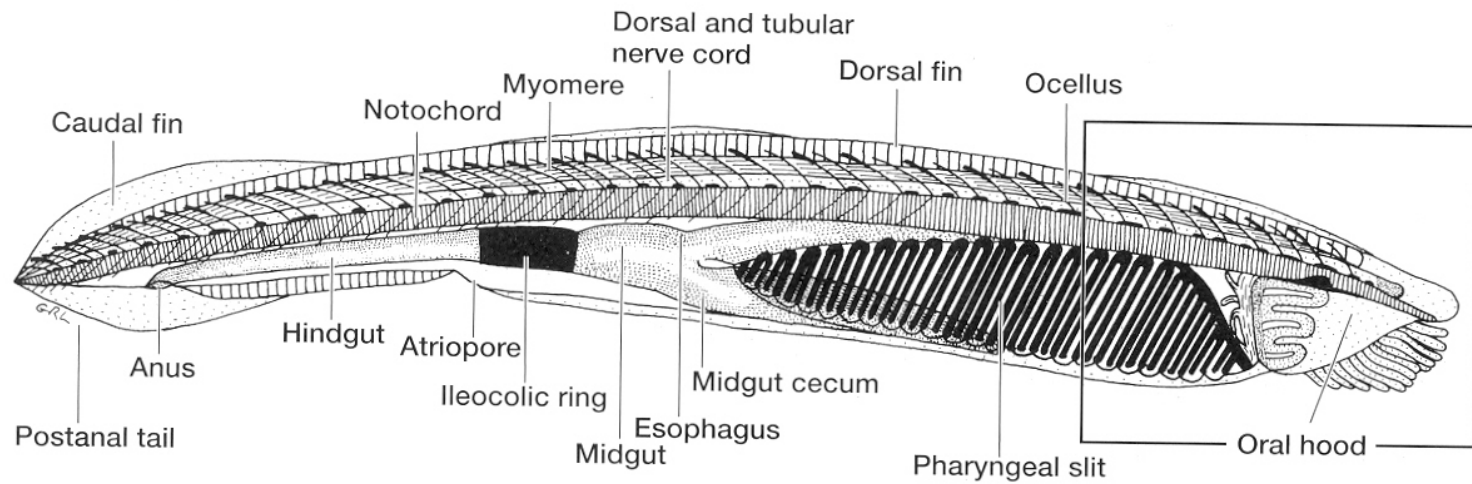
Brasil: criavam-se galinhas nas praias para que se alimentassem de anfioxos

Anfioxo: duas pontas

4 a 8 cm, transparentes e iridescentes

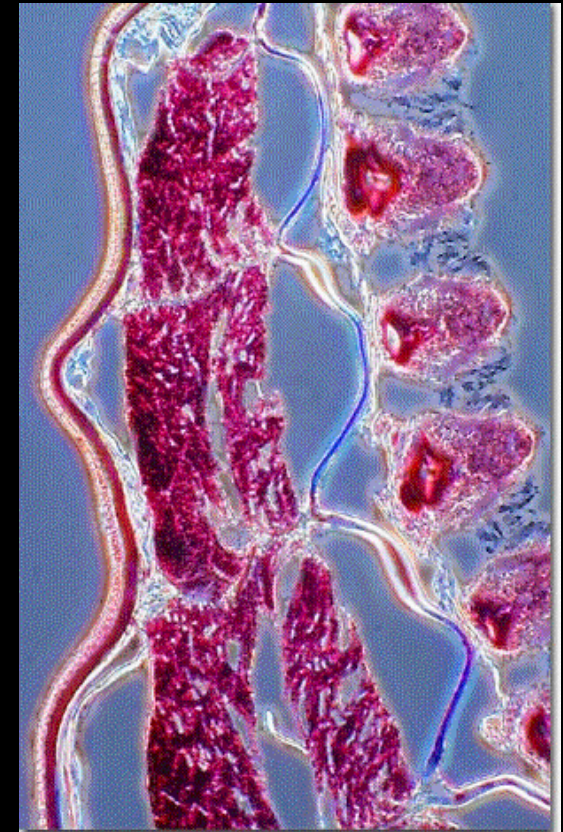
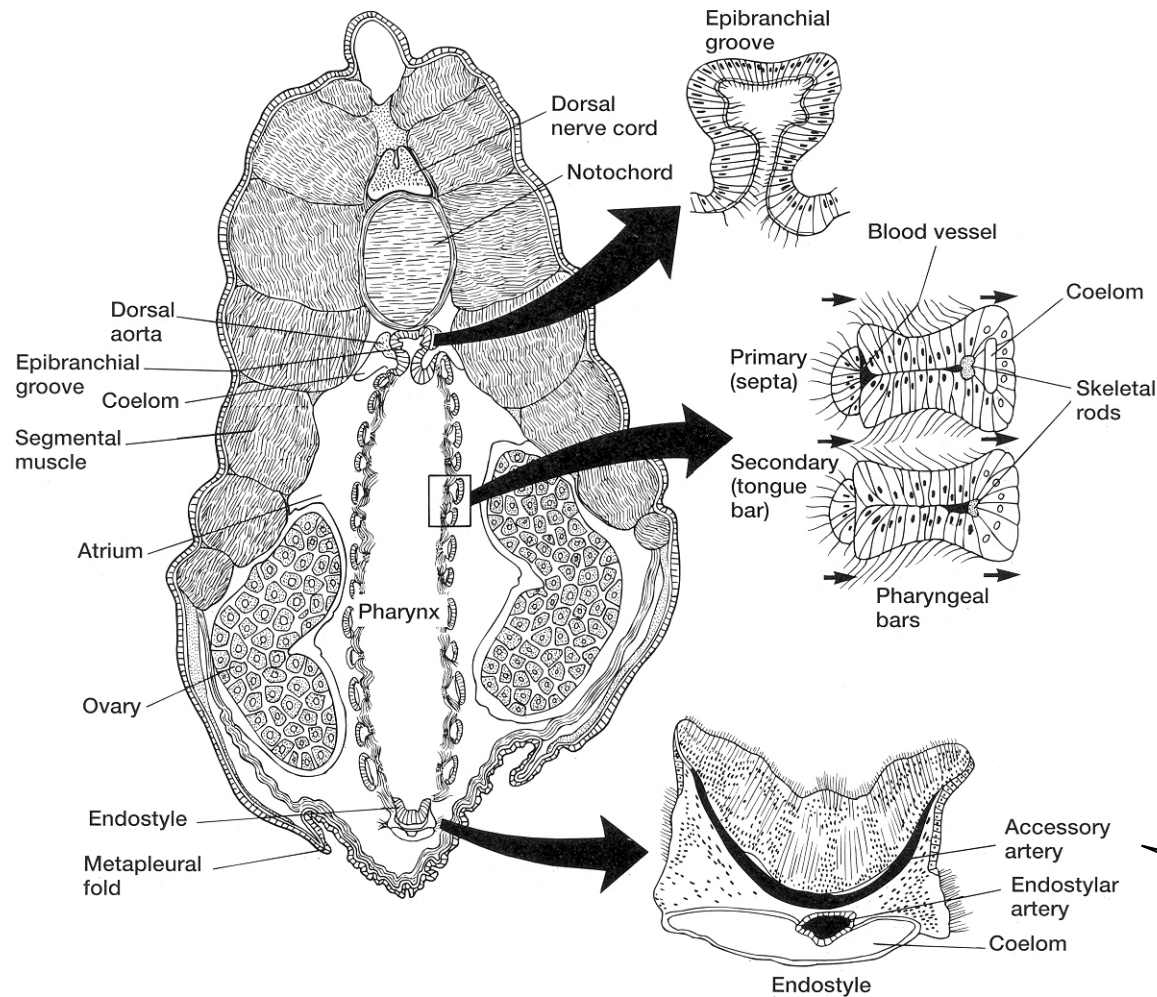


Organização Geral



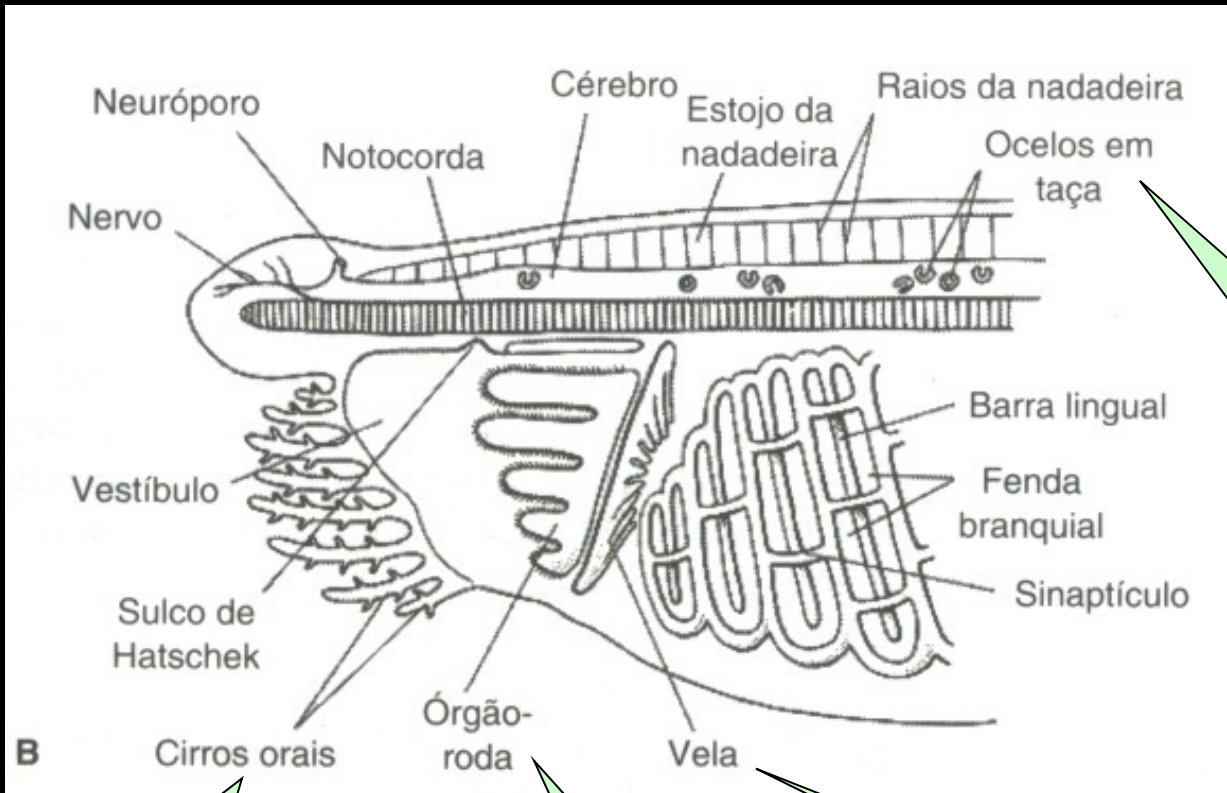
Organização Geral

Encaminha o muco para o intestino



Secreta a rede mucosa

Região da Cabeça

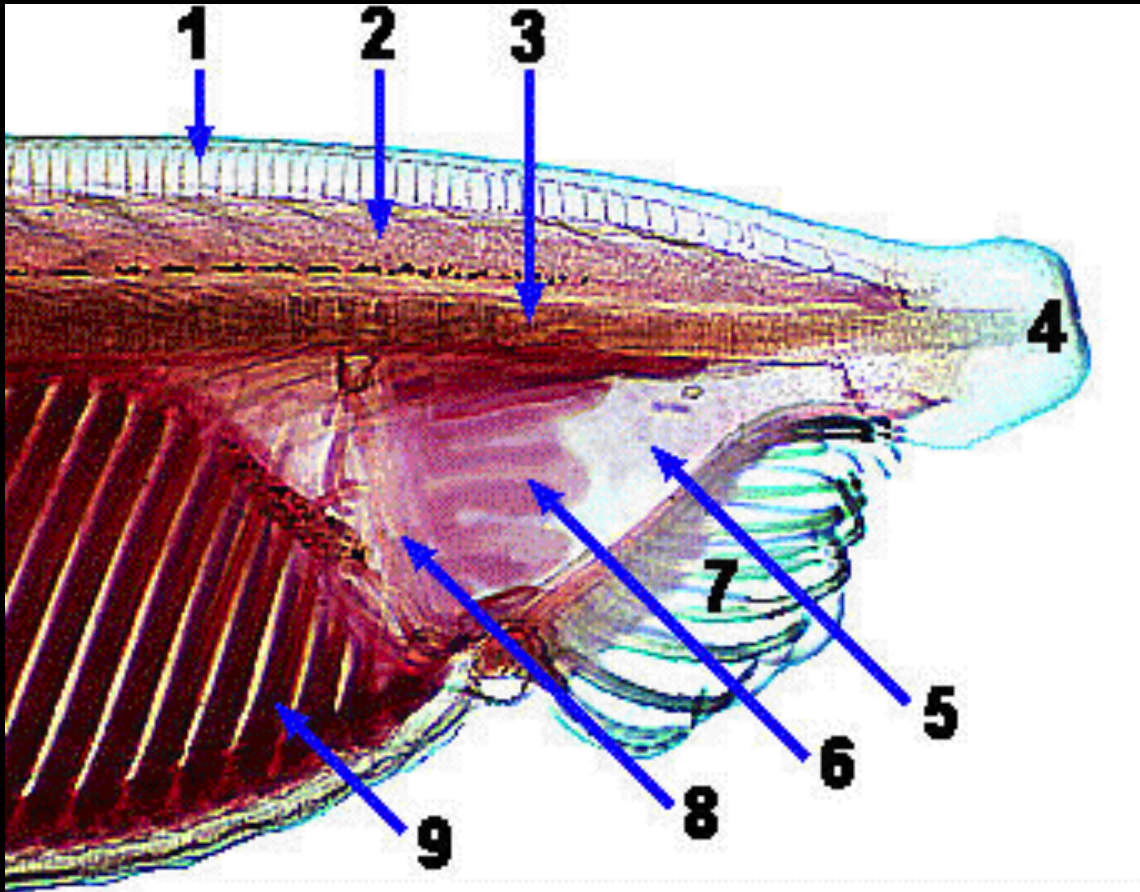


Ocelos (até 1500)
Lado esquerdo: luz que vem de cima
Lado direito: luz que vem de baixo

Impedem entrada de partículas grandes
Testam qualidade da água

Fluxo de água

Esfíncter e células sensoriais



1. Nadadeira dorsal e raio da nadadeira

2. Cordão nervoso dorsal

3. Notocorda

4. Rostro

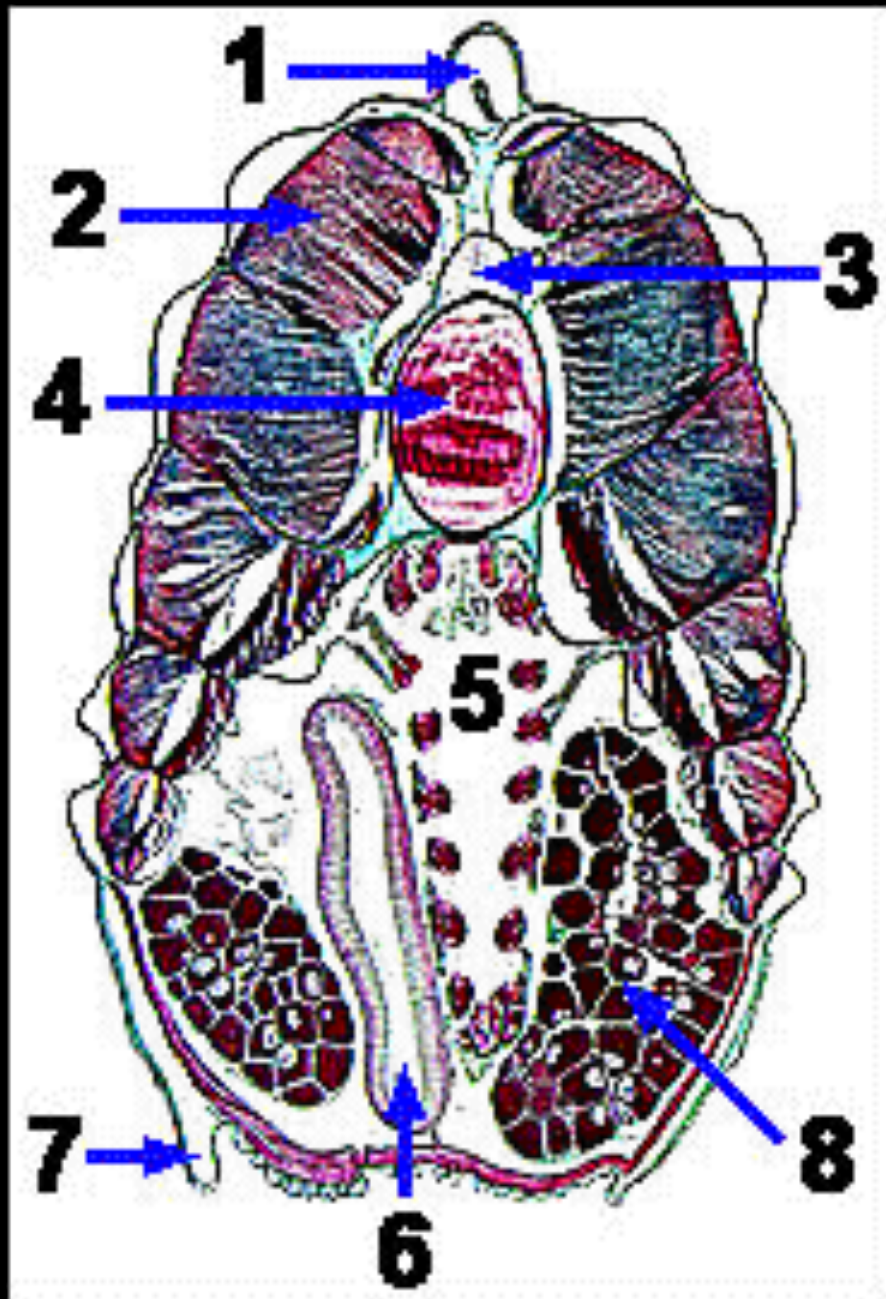
5. Vestíbulo oral

6. Órgão da roda

7. Cirros orais

8. Velo

9. Barra branquial



1. Nadadeira dorsal

2. Miômero

3. Cordão nervoso dorsal

4. Notocorda

5. Faringe

6. Ceco hepático

7. Prega metapleural

8. Gônada

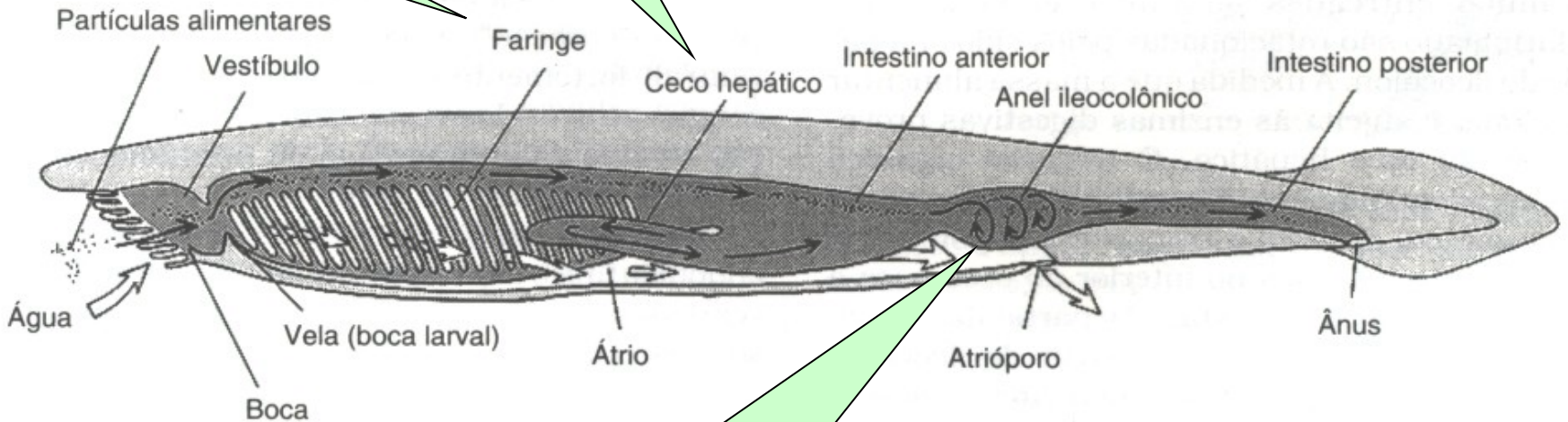
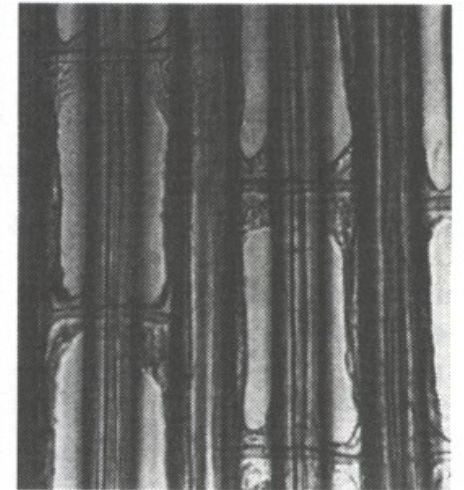
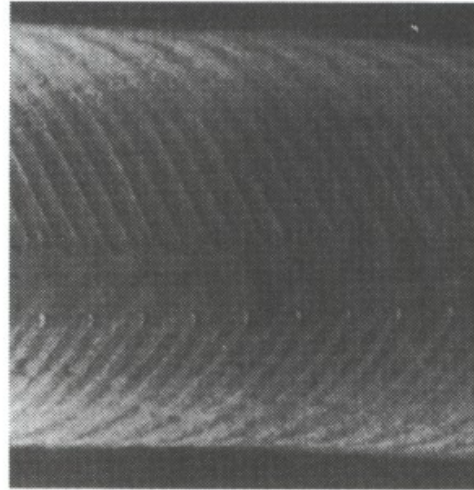


1. Átrio
2. Faringe
3. Ceco hepático
4. Endóstilo
5. Gônada
6. Pregas metapleurais

Organização Funcional do Sistema Digestivo

Glândula digestiva
Digestão intracelular e
armazenamento de nutrientes

Faringe ciliada (180
pares de fendas)

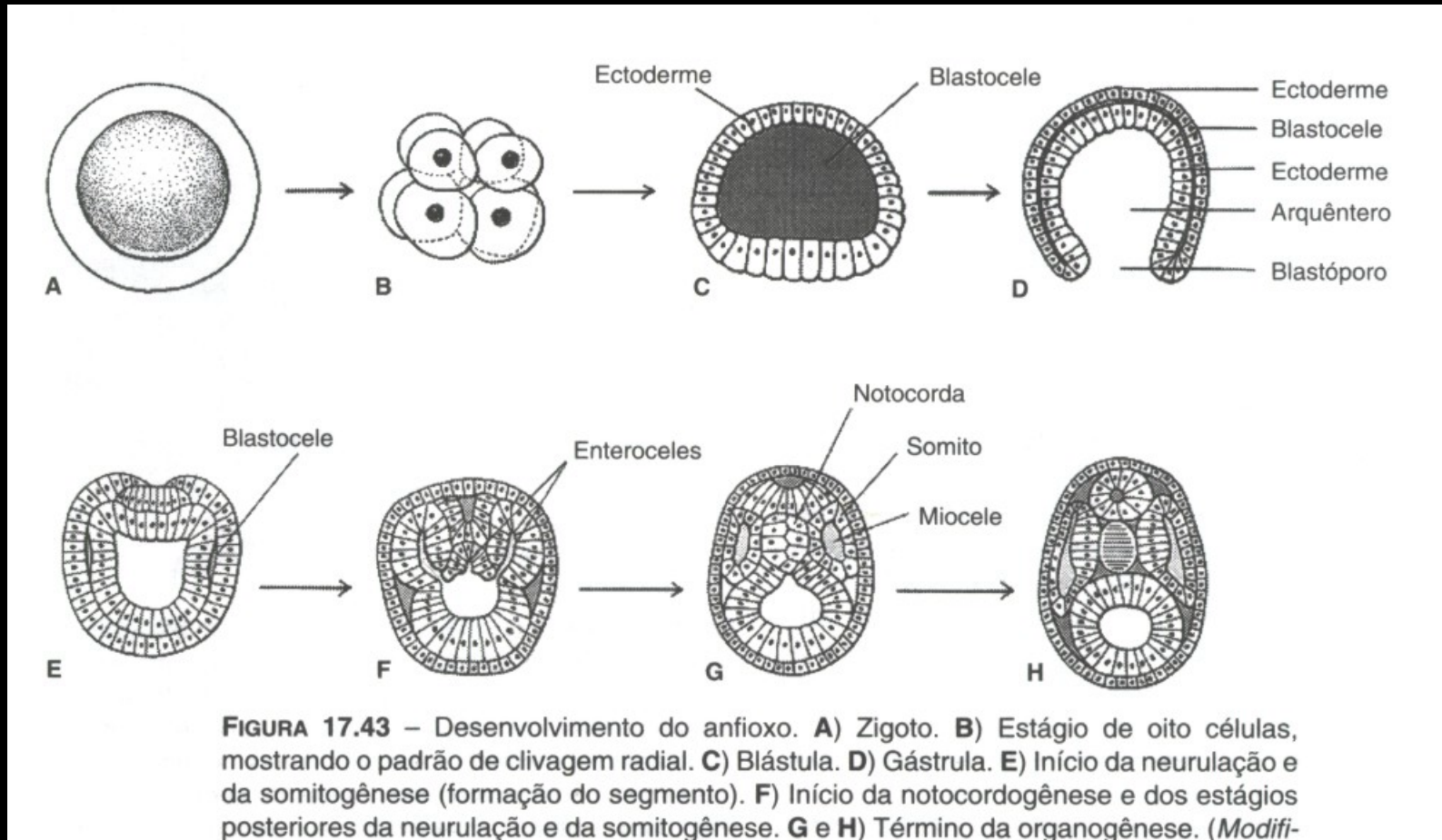


Gira o o cordão mucoso,
misturando-o com as enzimas

Reprodução e Desenvolvimento

Dióicos, fecundação externa, ciclo de vida complexo

26 pares de gônadas (miômeros 10 a 35)

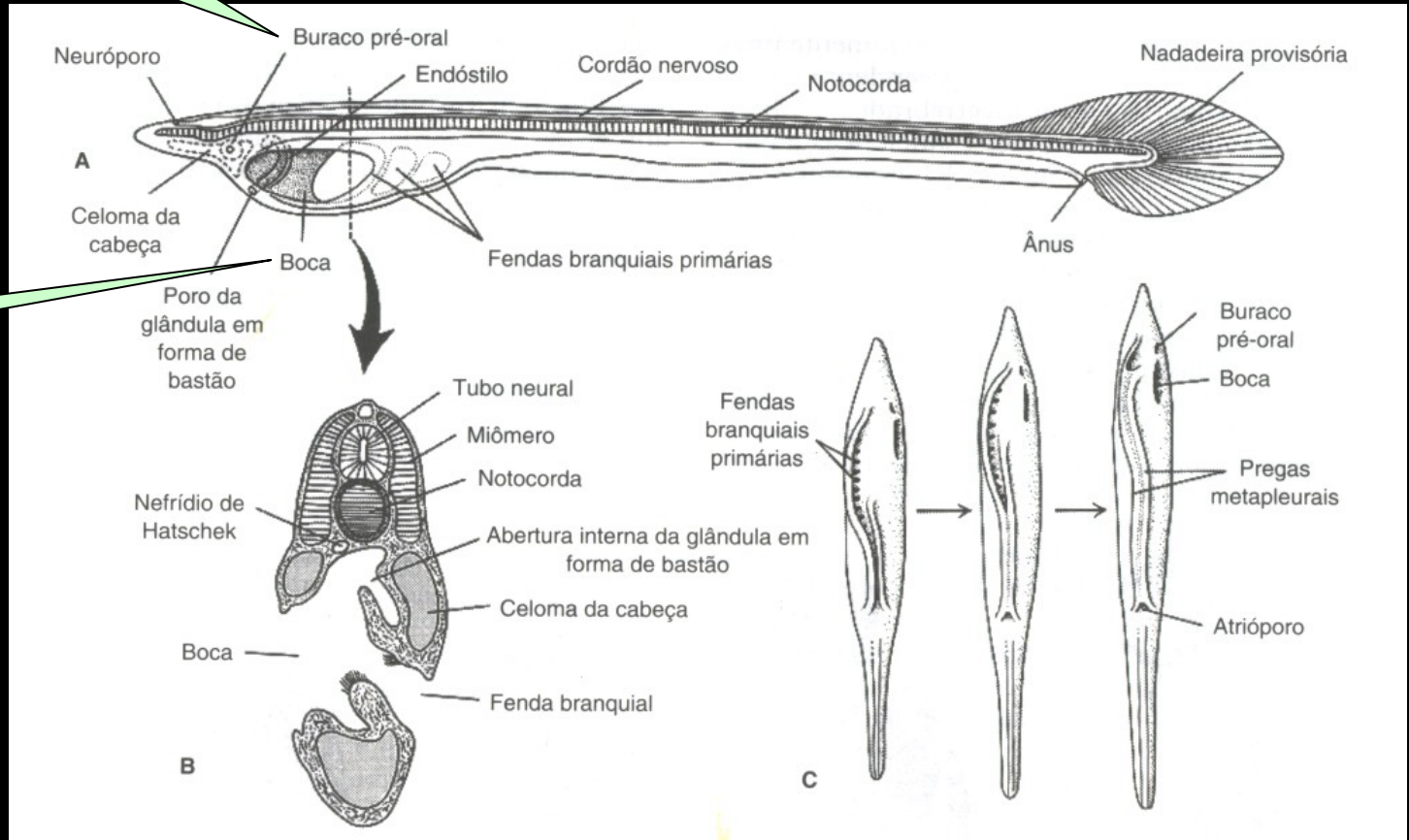


Larva e Metamorfose

Larva anteriormente assimétrica: boca destra, fendas faríngeas sinistras

Órgão da roda

Velo





UROCHORDATA

(tunicados)
2000 espécies

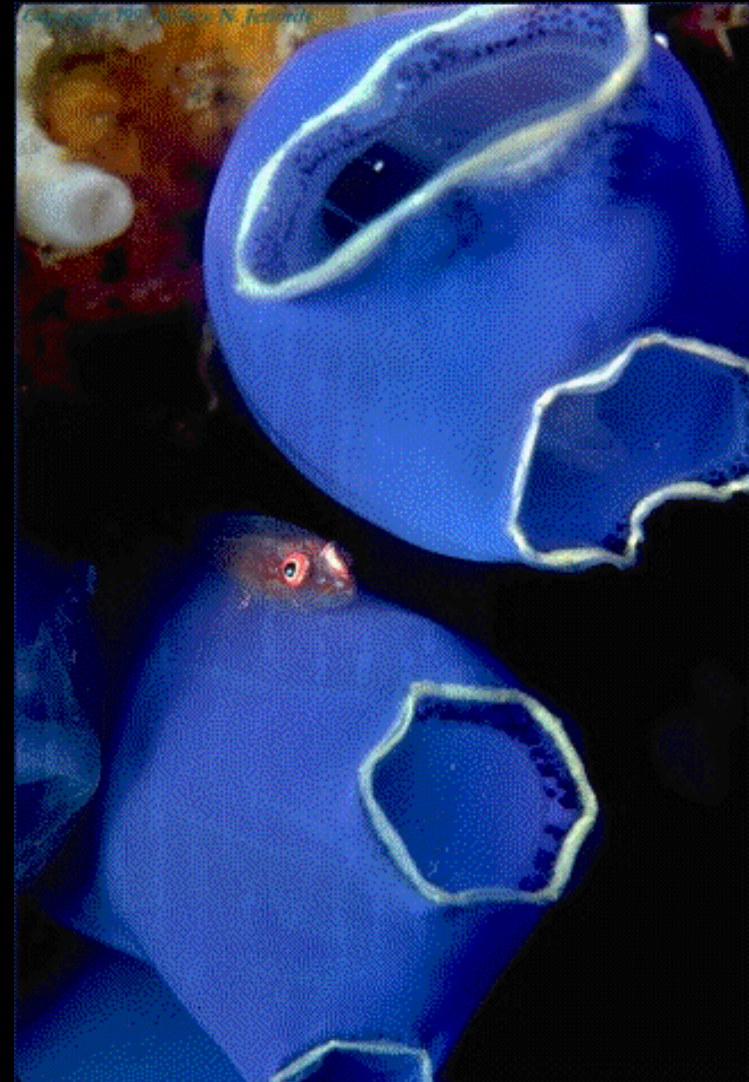
Marinhos, maioria sésil em águas rasas

Corpo com túnica

Notocorda e tubo nervoso ausentes no adulto

Ascidiacea (maioria das espécies)

Thaliacea e Larvacea (planctônicos)



Tradicionalmente:

Três classes

Ascidiacea (sésseis; maioria das espécies)

Aplousobranchia

Phlebobranchia

Stolidobranchia

Thaliacea (planctônicos)

Pyrosomida

Doliolida

Salpida

Larvacea (planctônicos)

MP/NJ/ME



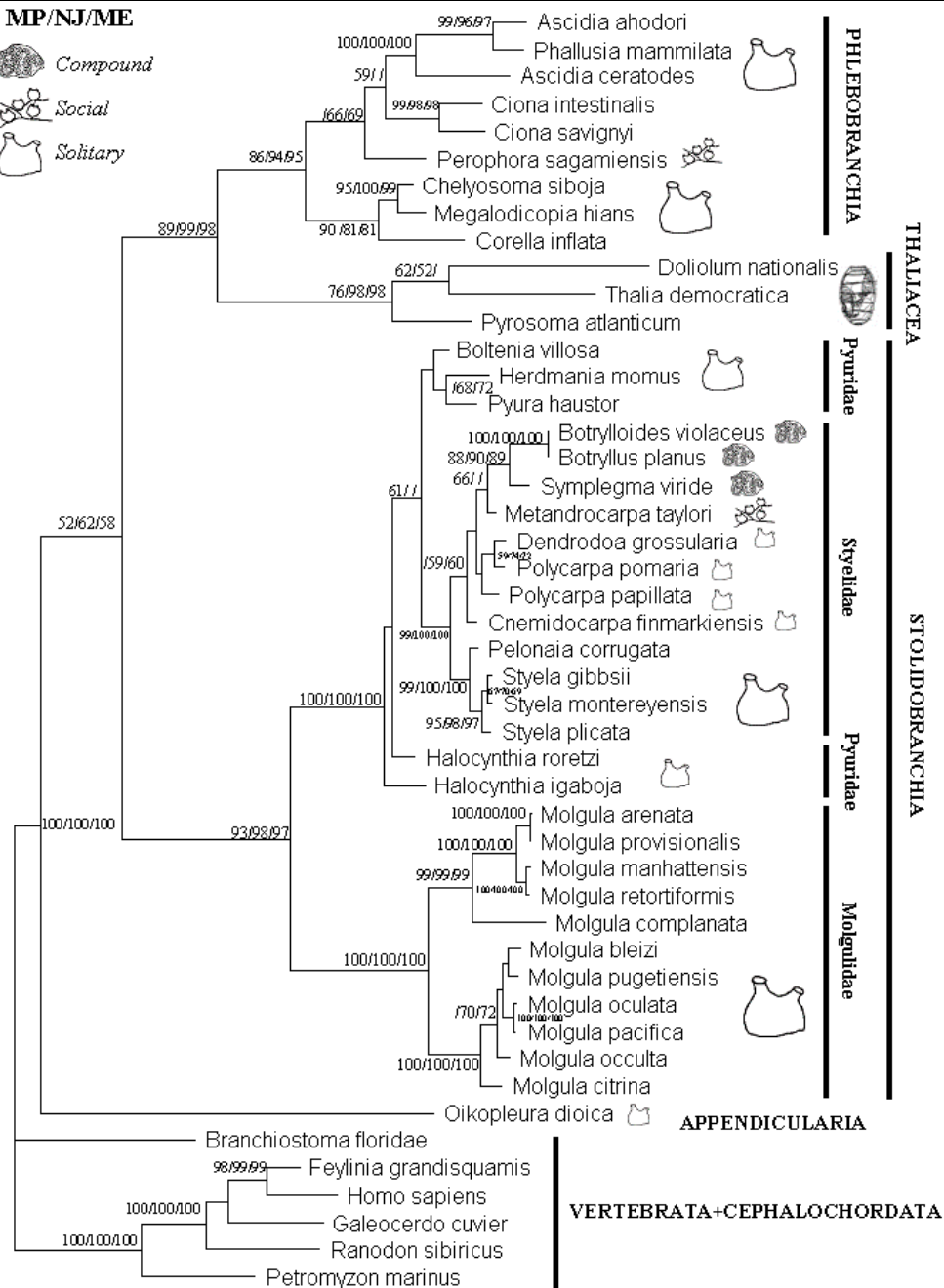
Compound



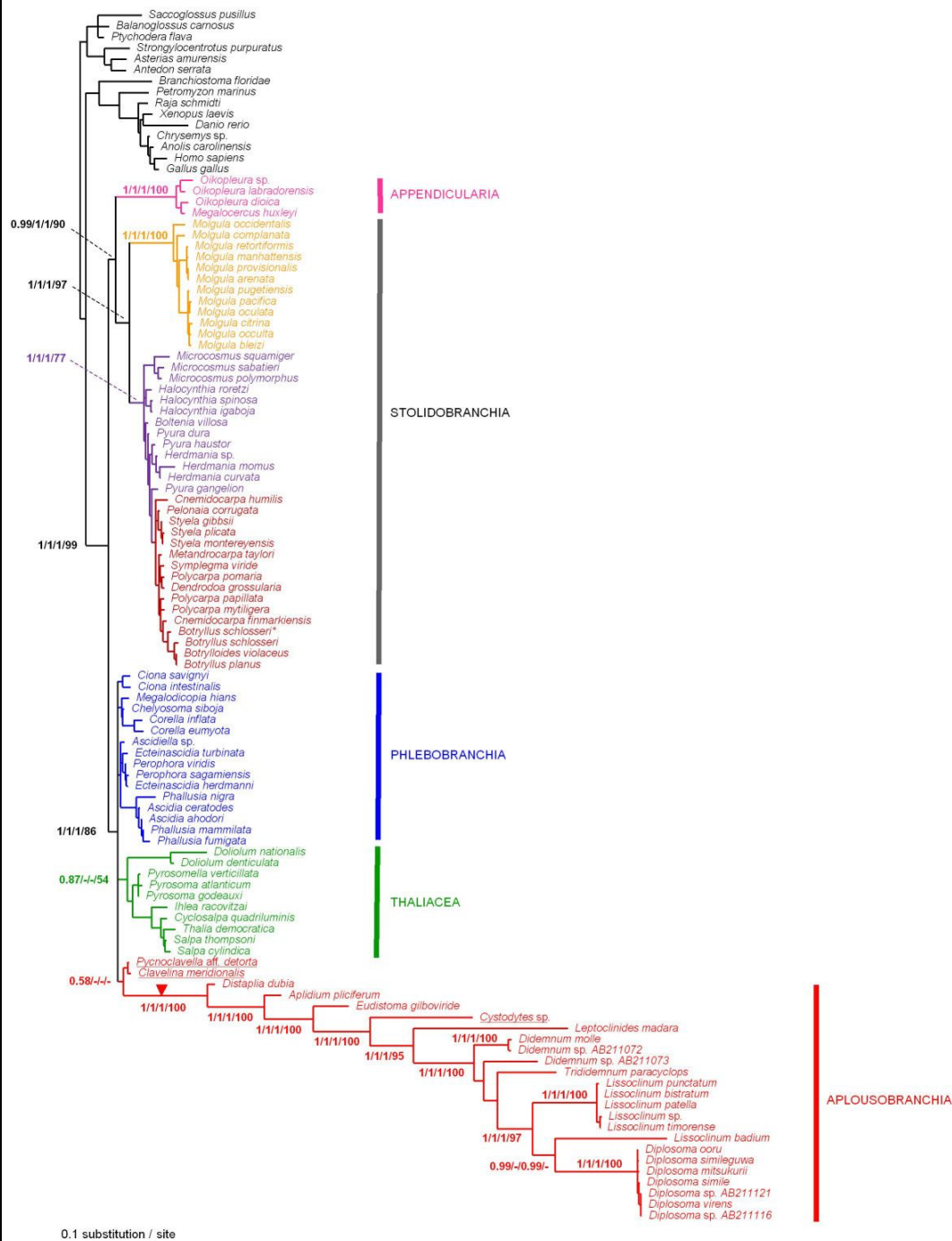
Social

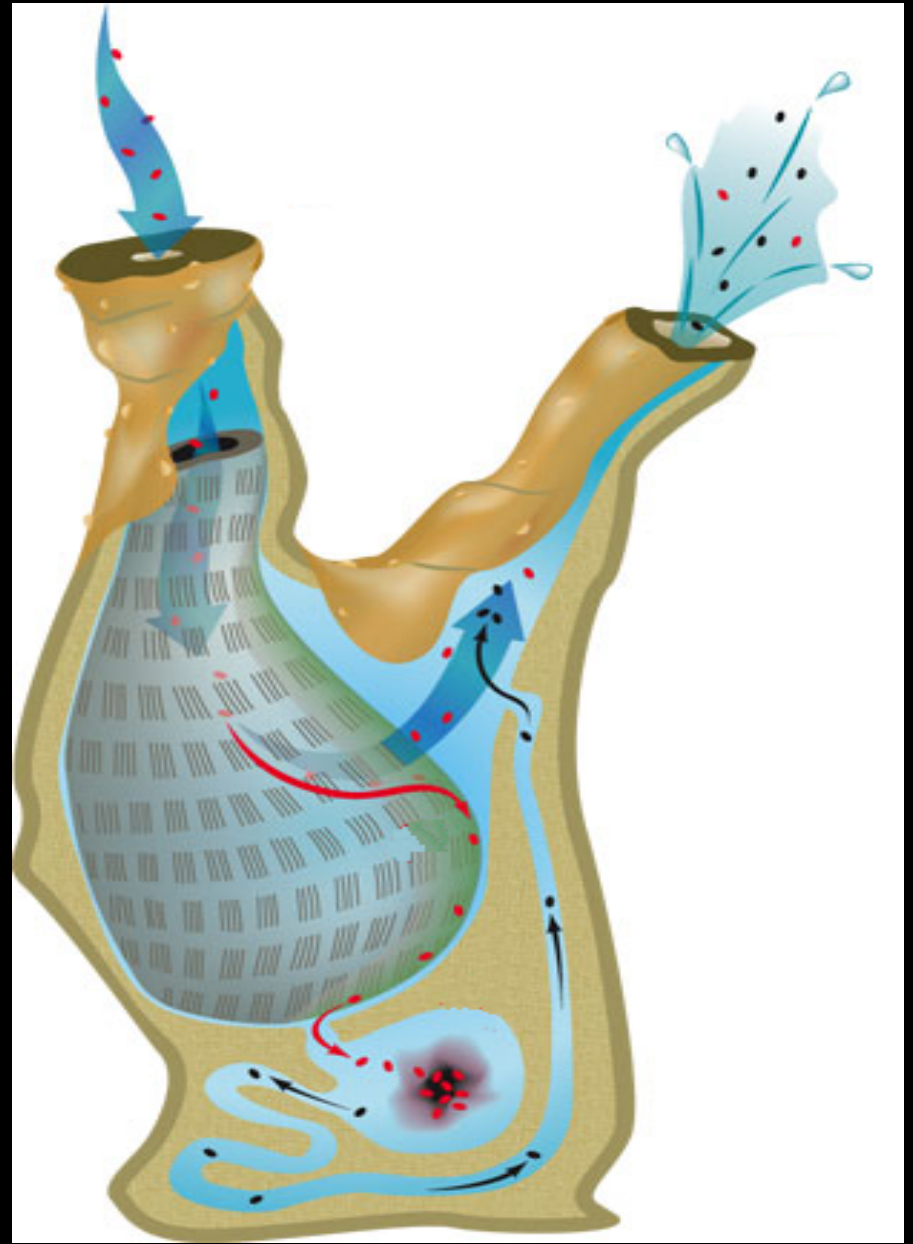


Solitary



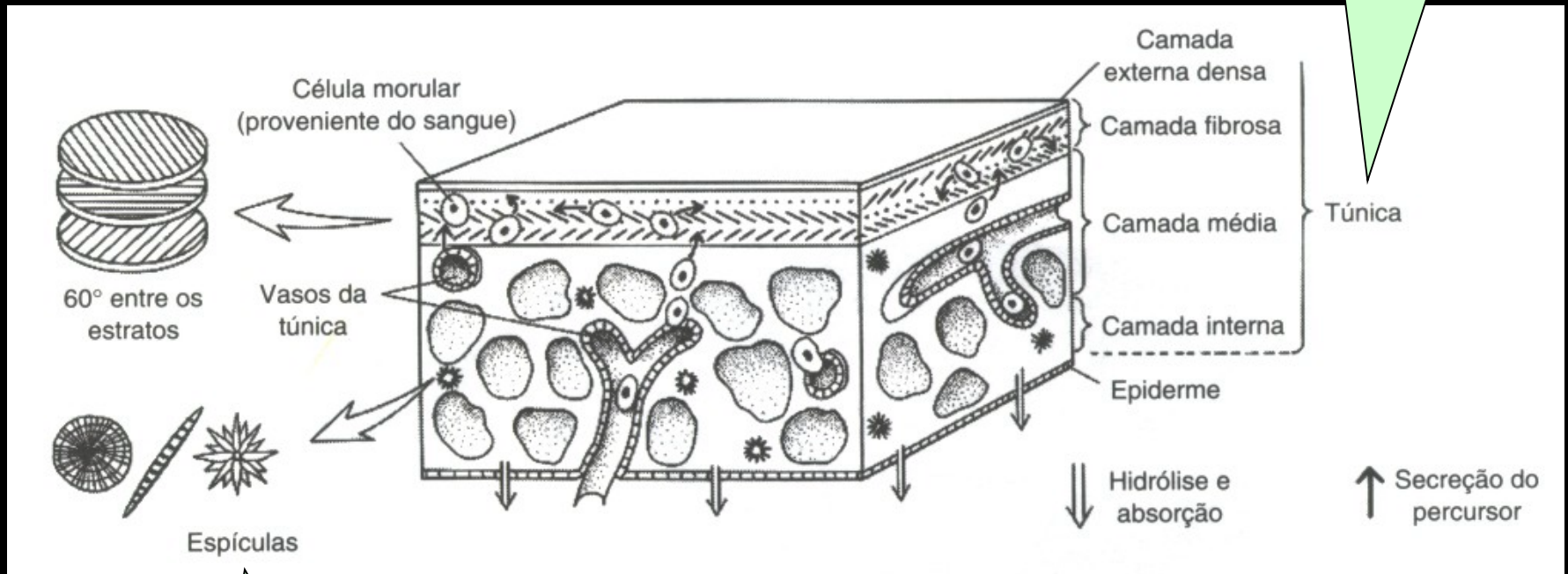
— 10 changes





Estrutura da Túnica

Exoesqueleto vivo
Tunicina
(tipo de celulose)



Calcáreas
Silicosas
Material fecal

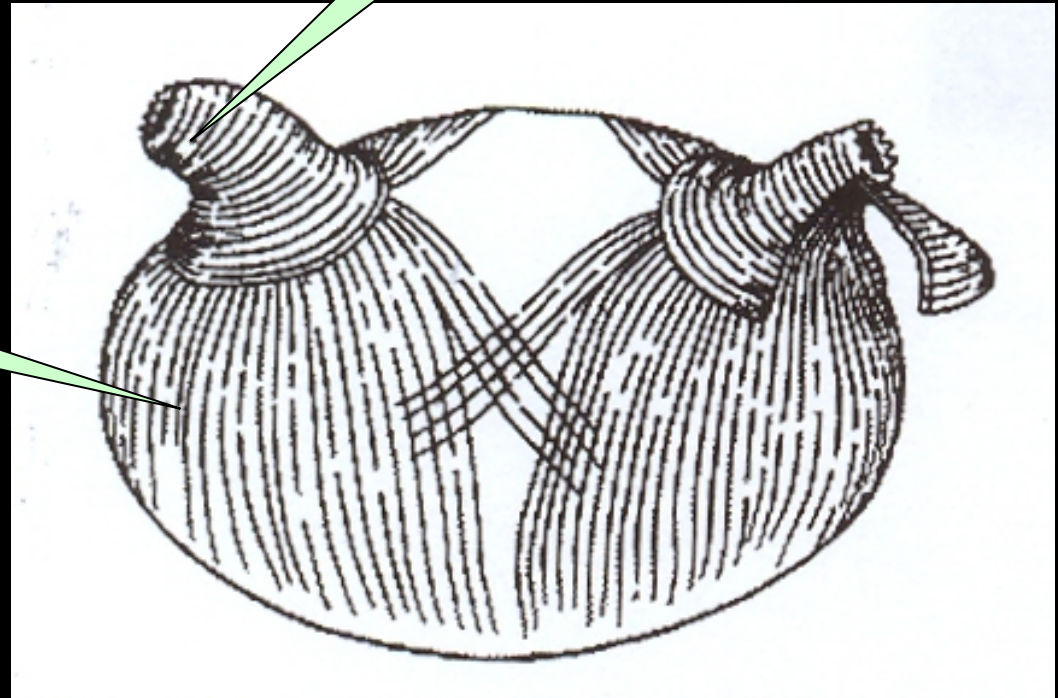
Musculatura Lisa



Pyura

Longitudinal interna
(retração dos sifões)

Circular externa
(esfíncteres)

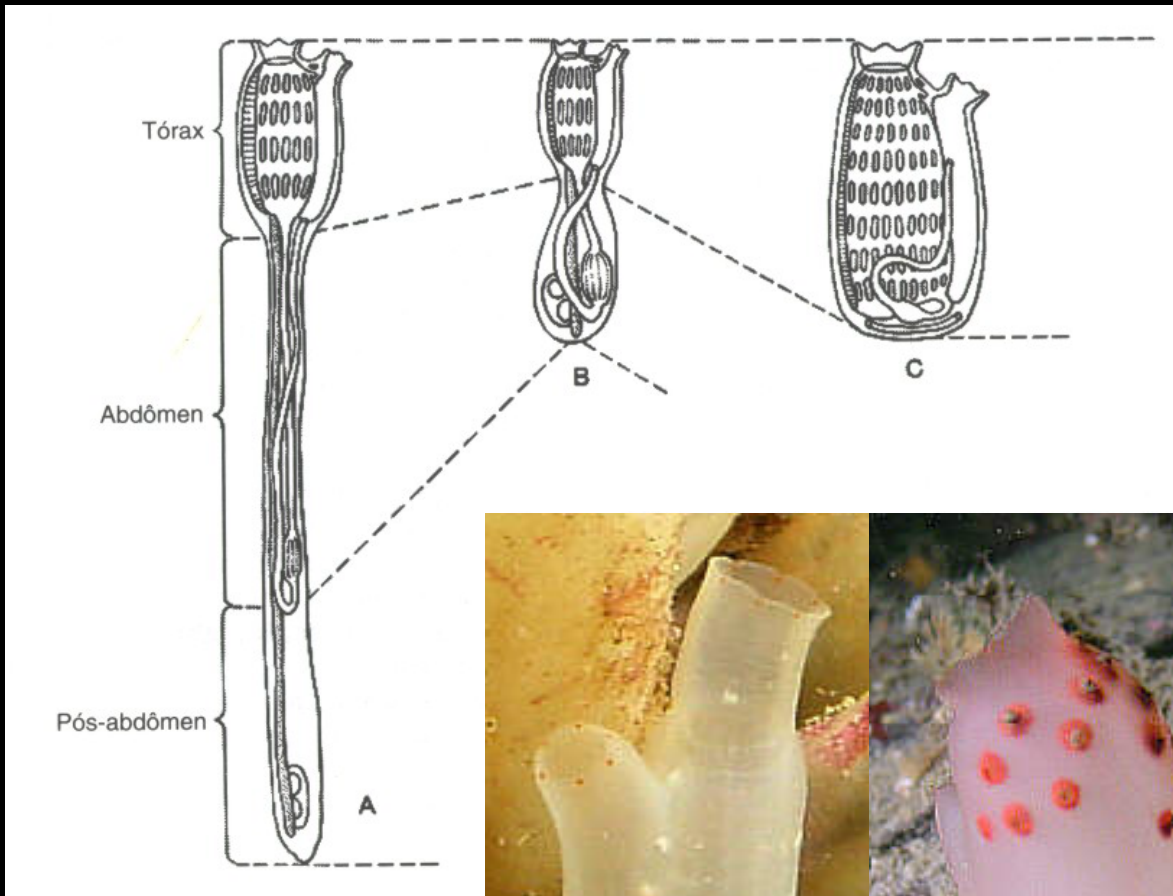


Formas Corporais

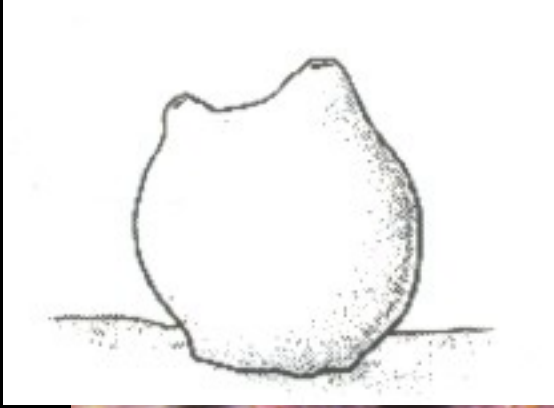
A. Aplousobranchia

B. Phlebobranchia

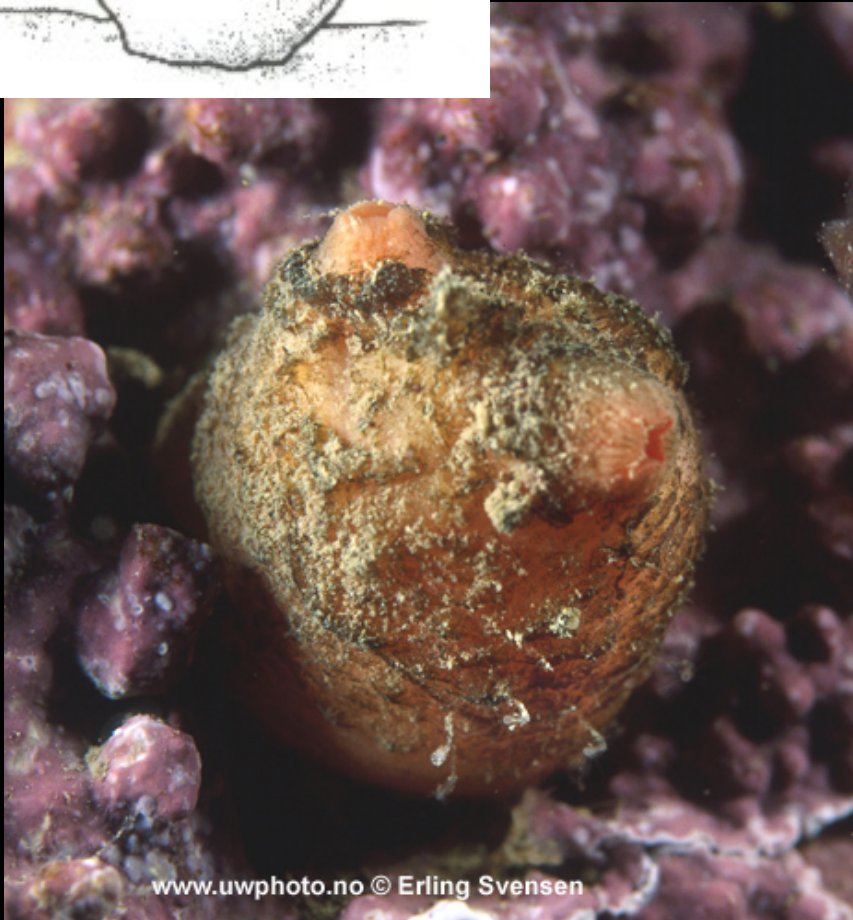
C. Stolidobranchia



Ascídias Solitárias

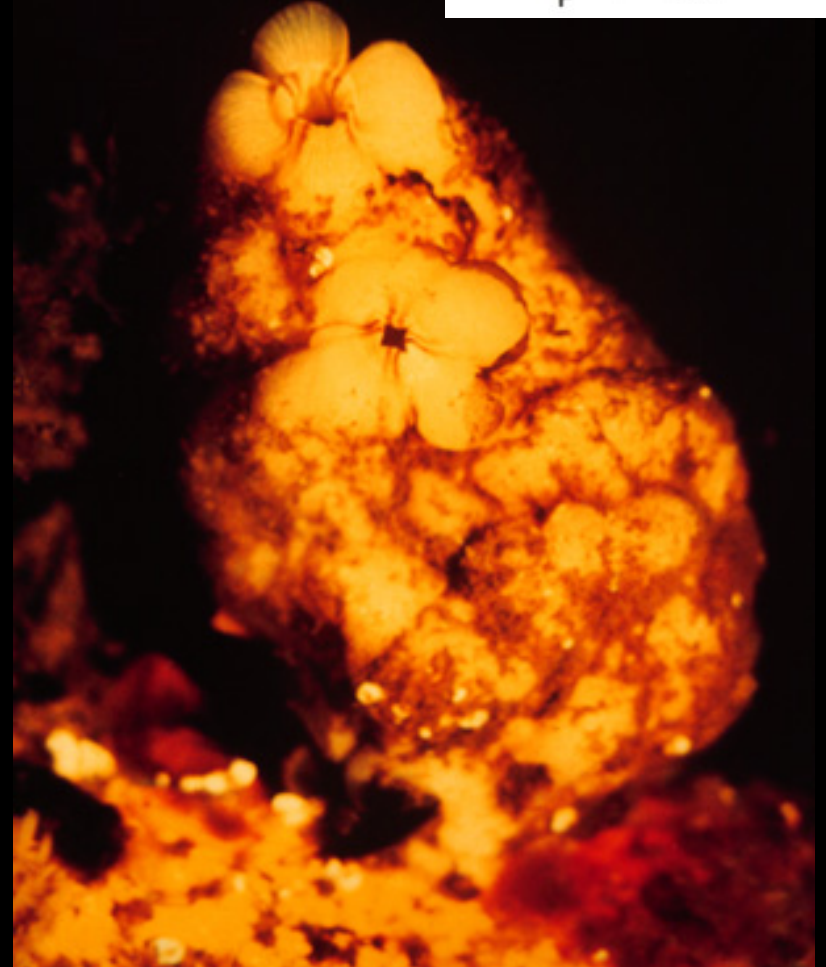
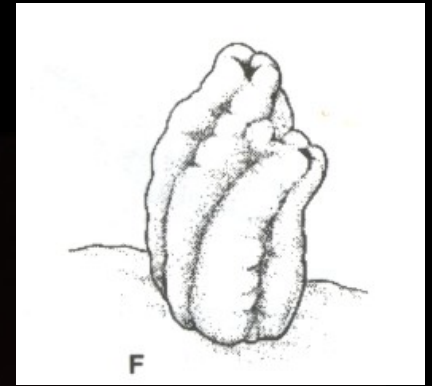


*Molgula
manhatensis*

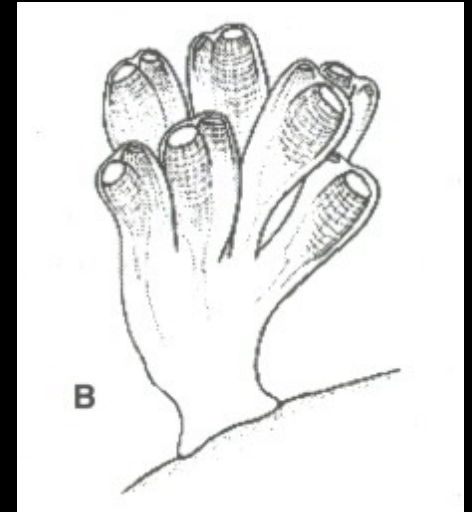
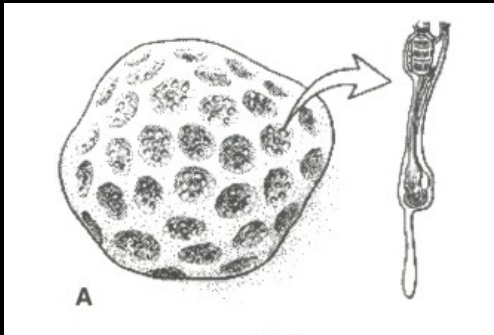


www.uwphoto.no © Erling Svensen

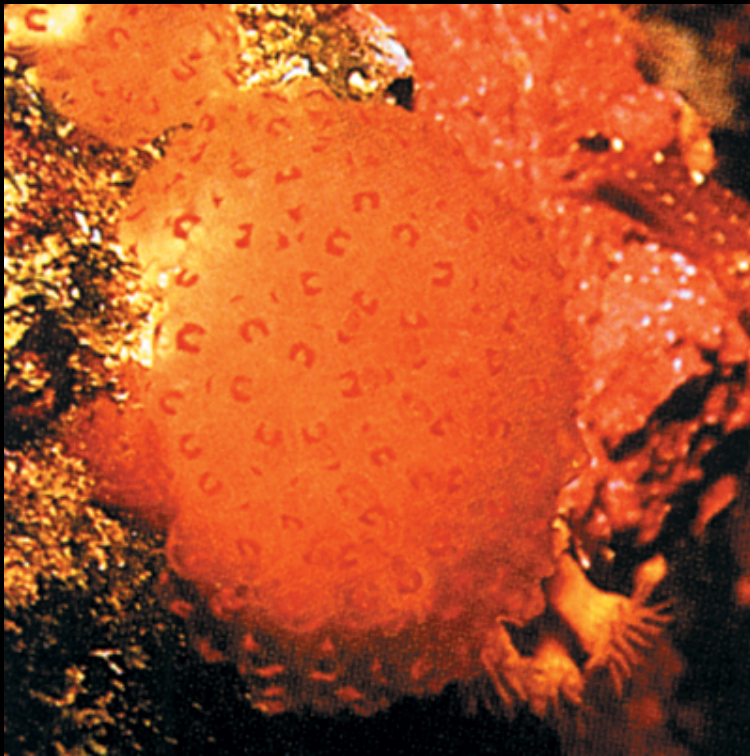
Styela plicata



Ascídias Coloniais

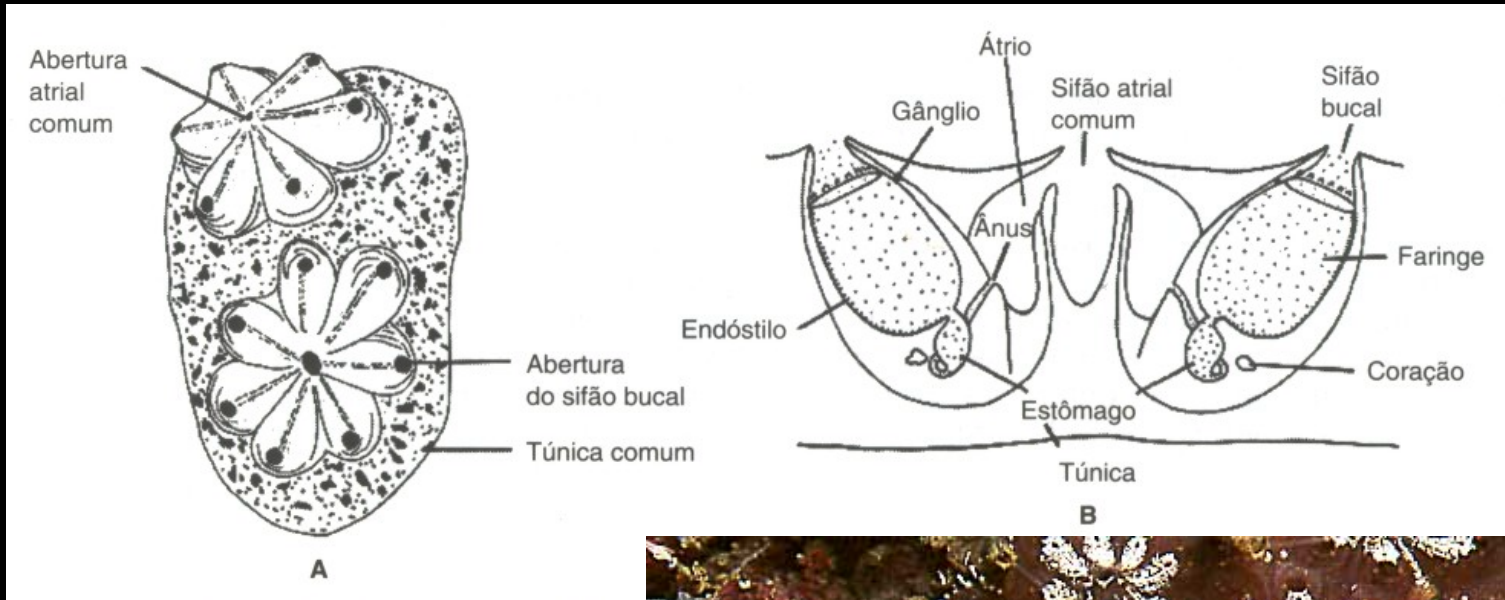


Clavelina oblonga



Aplidium stalletum





Ascídias Compostas

Botryllus schlosseri

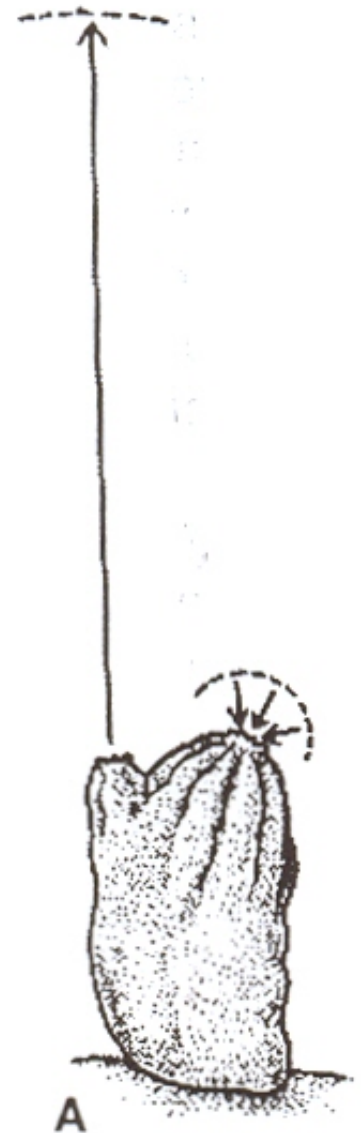


Alimentação

Filtradores de plâncton

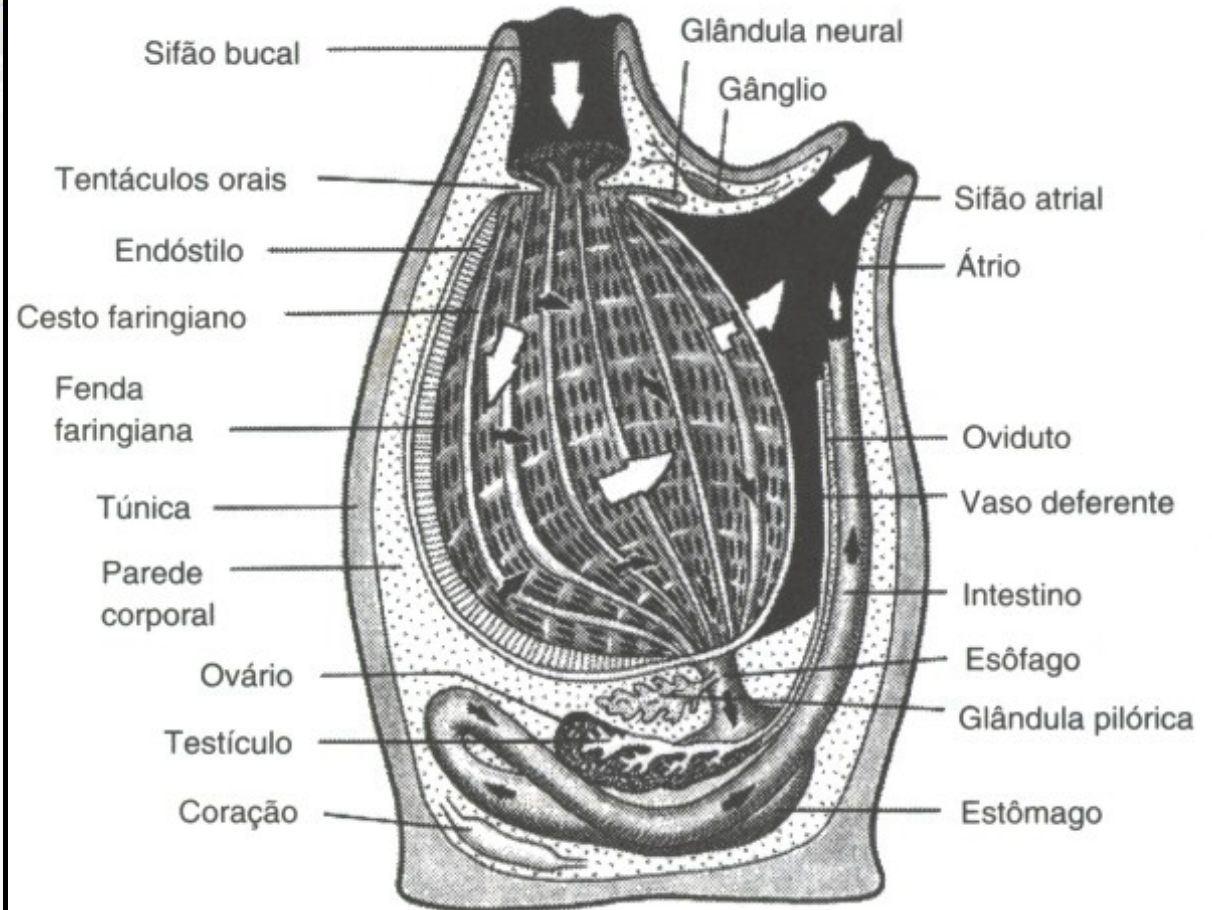
Batimento ciliar das margens das fendas faríngeas

Ascidia nigra: filtra 173 litros/dia



Faringe e Átrio

Origem ectodérmica



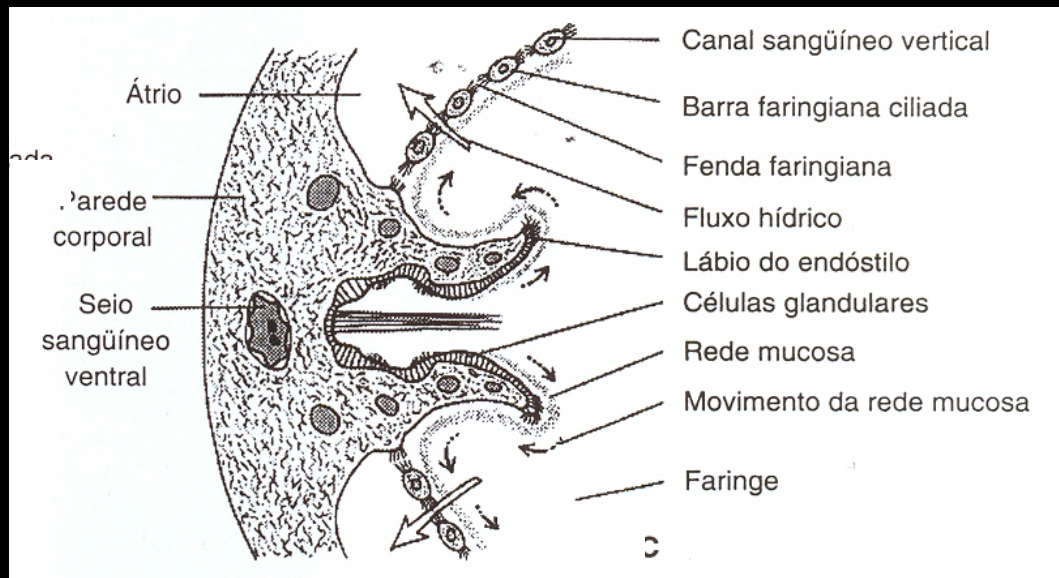
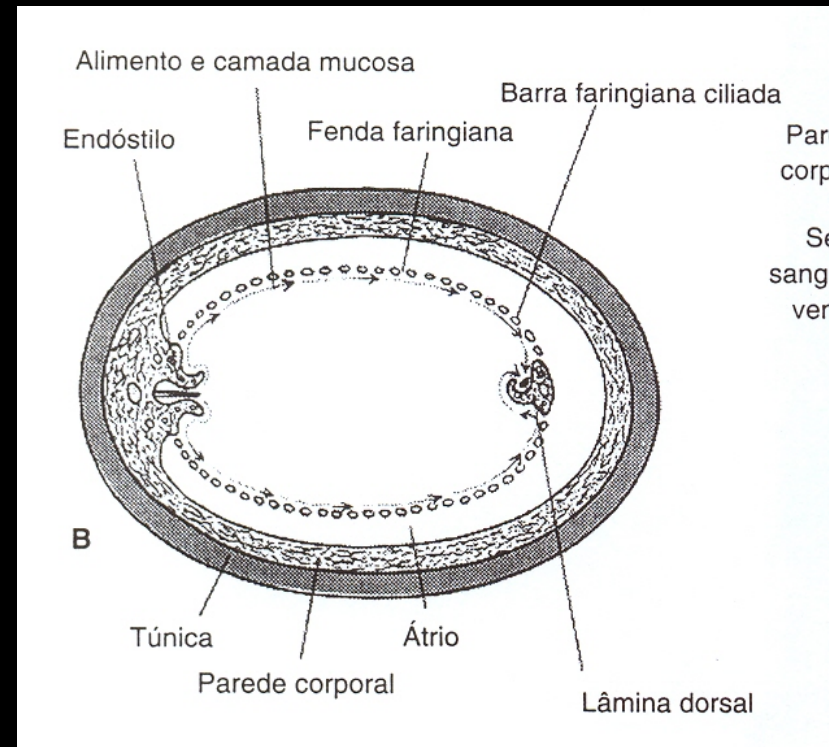
Alimentação

Endóstilo (= tireóide dos vertebrados)

Mucoproteína: iodo + tirosina

Rede filtradora: $0,5\mu\text{m}$ (detém bactérias)

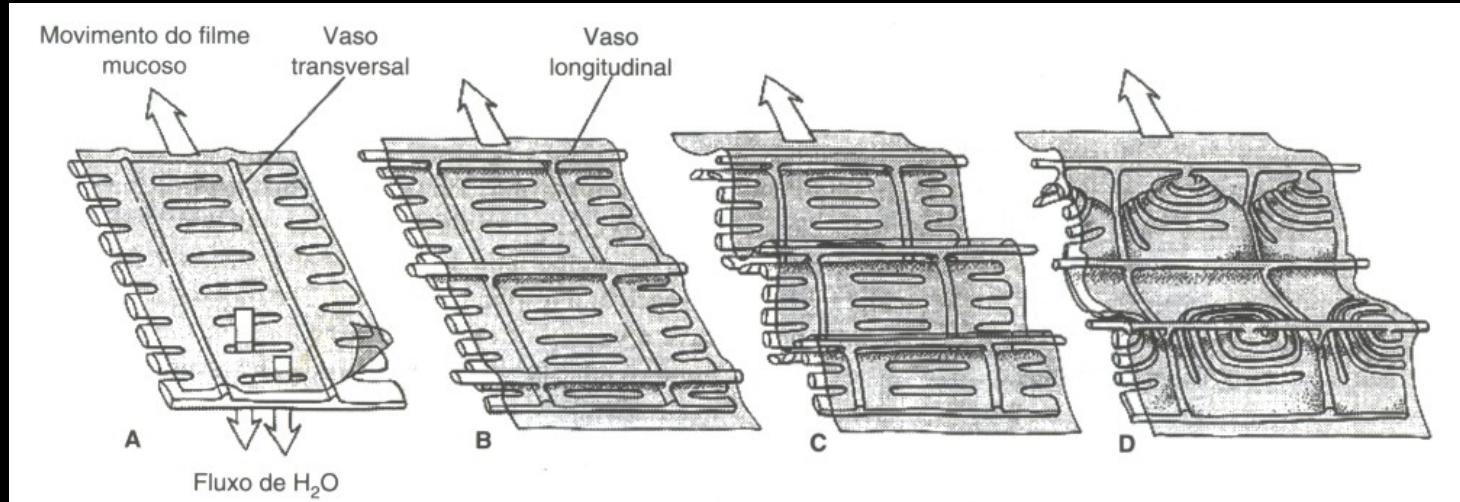
Lâmina dorsal: produz o cordão mucoso e o dirige para a faringe



Evolução da Faringe

Aumento da superfície: alimentação e trocas gasosas

Aumento de tamanho



Aplousobranchia



Phlebobranchia

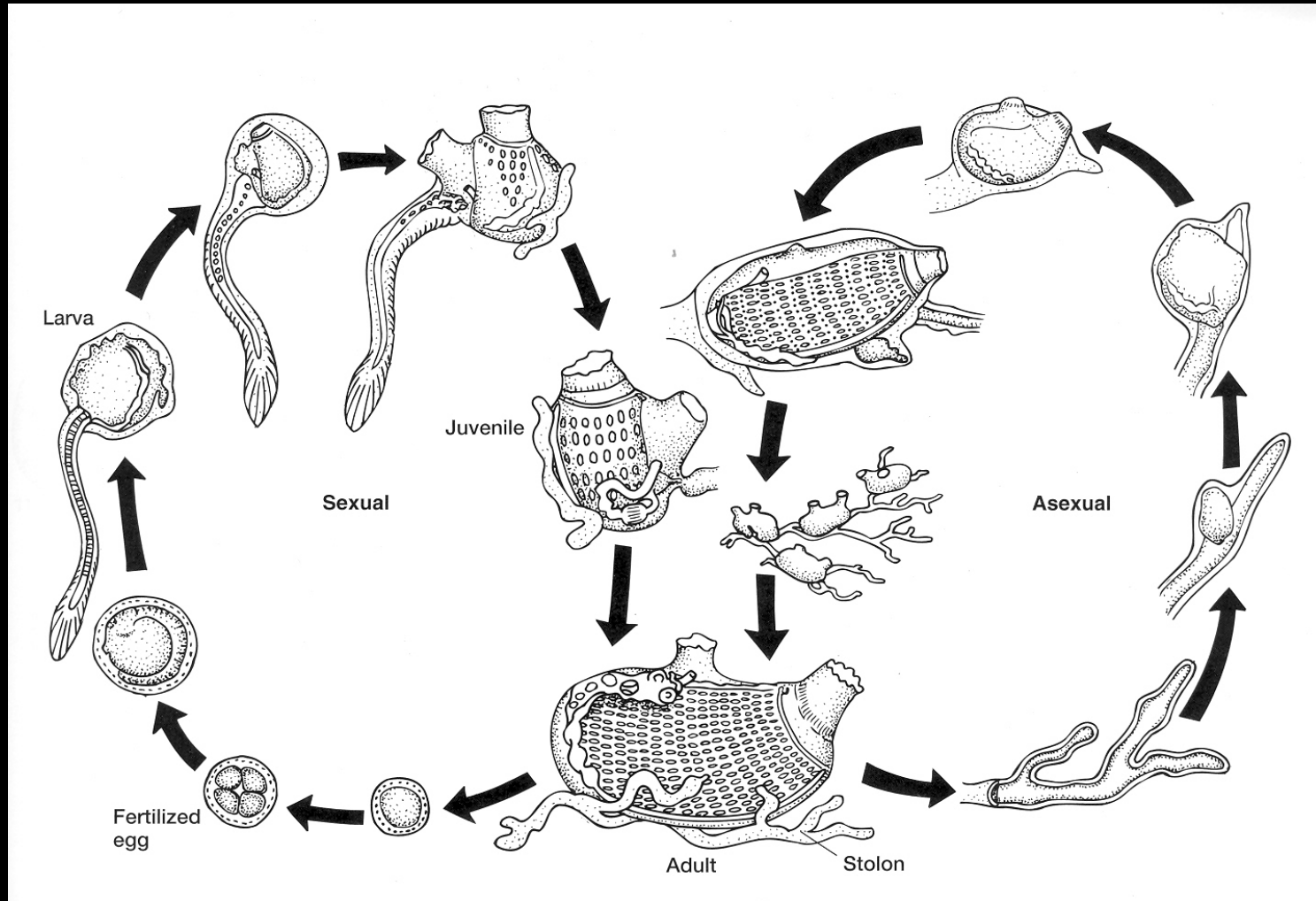


Stolidobranchia

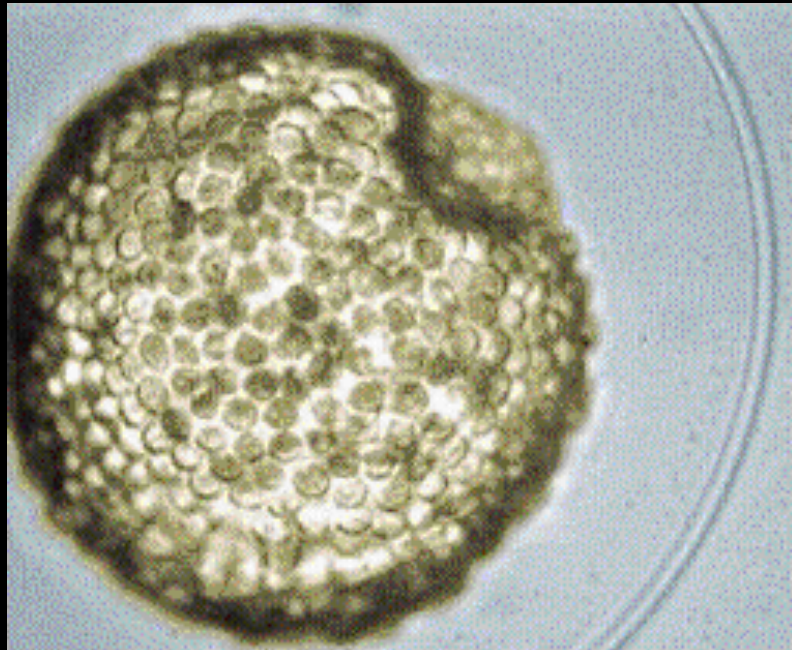
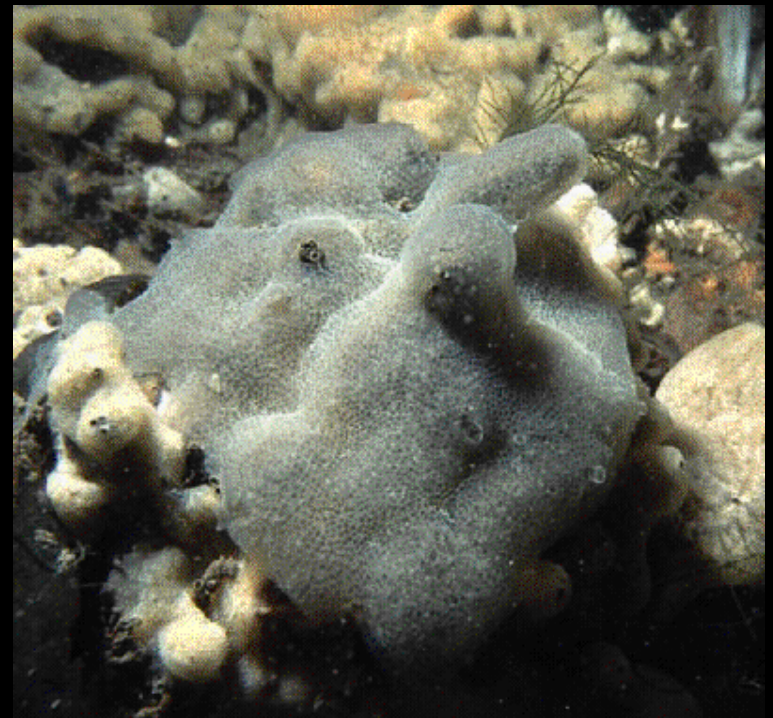
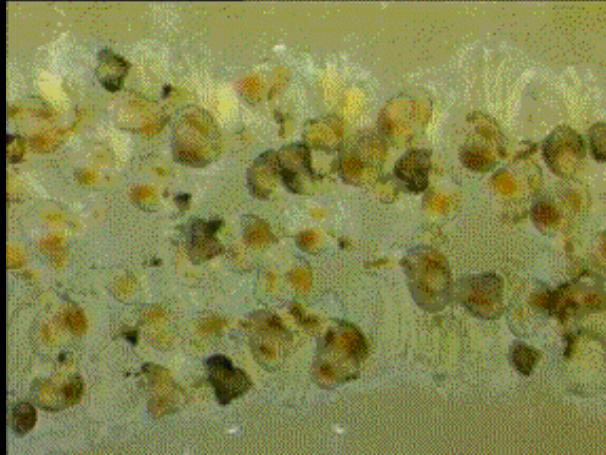
Reprodução

Hermafroditas, fecundação cruzada na água do mar

Larvas lecitotróficas: 36 horas ou menos

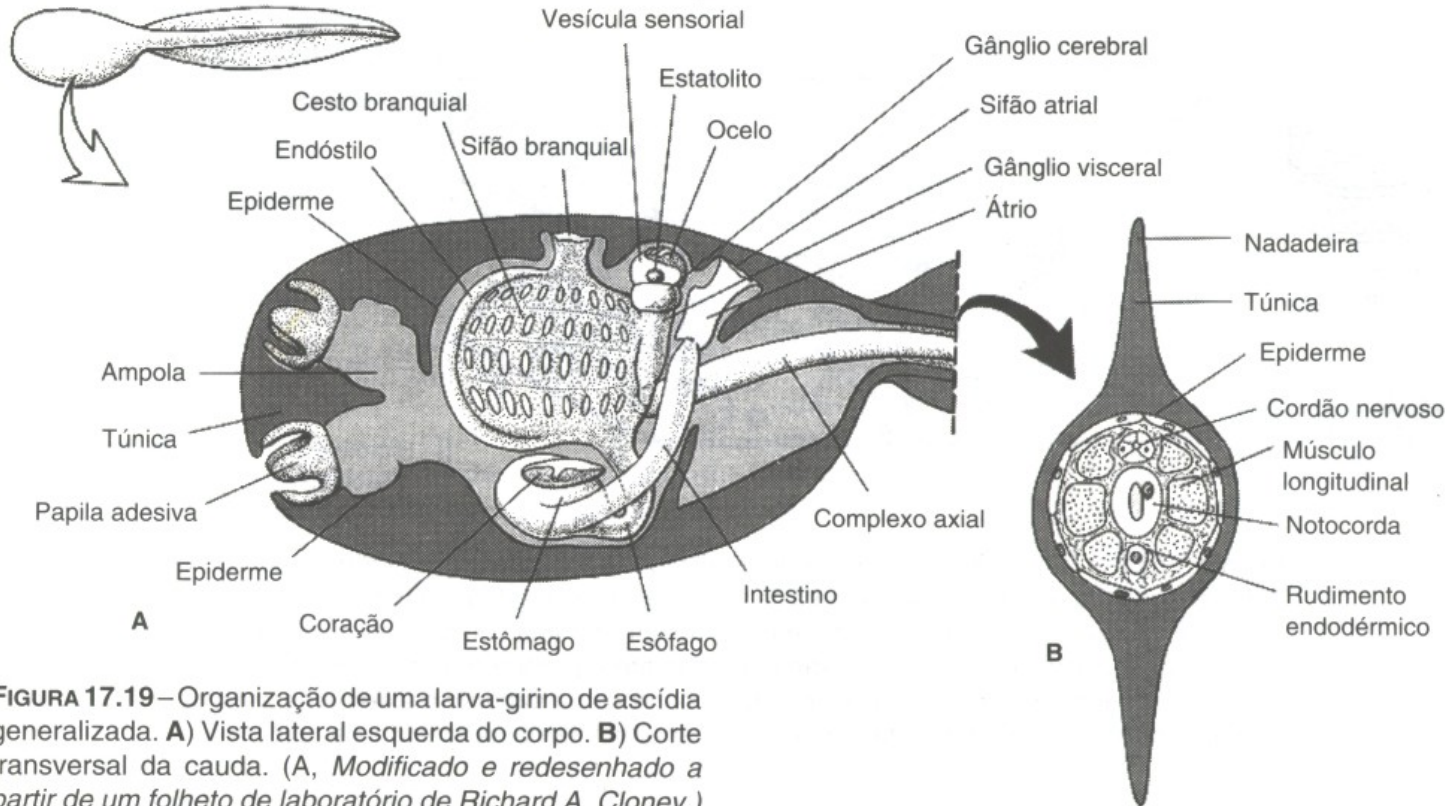
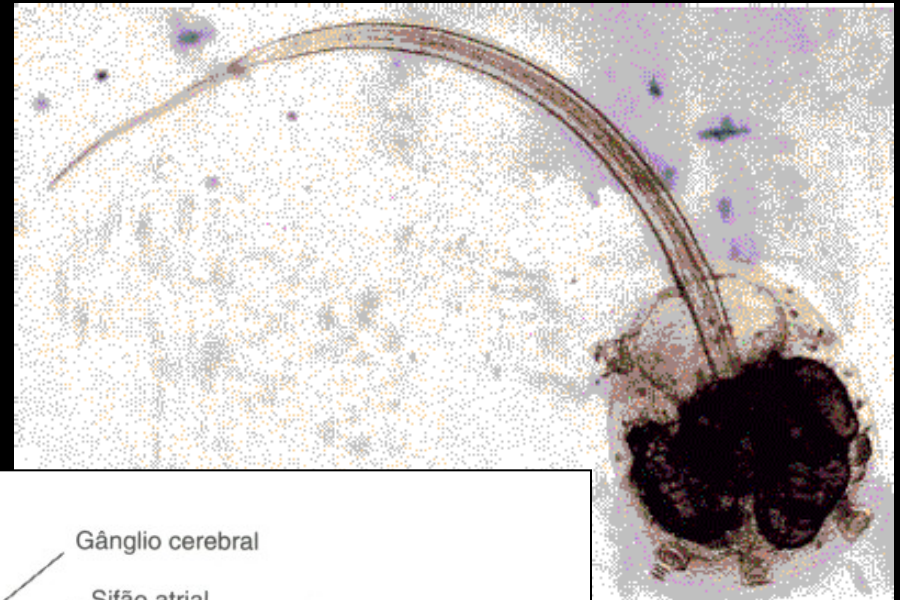


Ovos e embriões

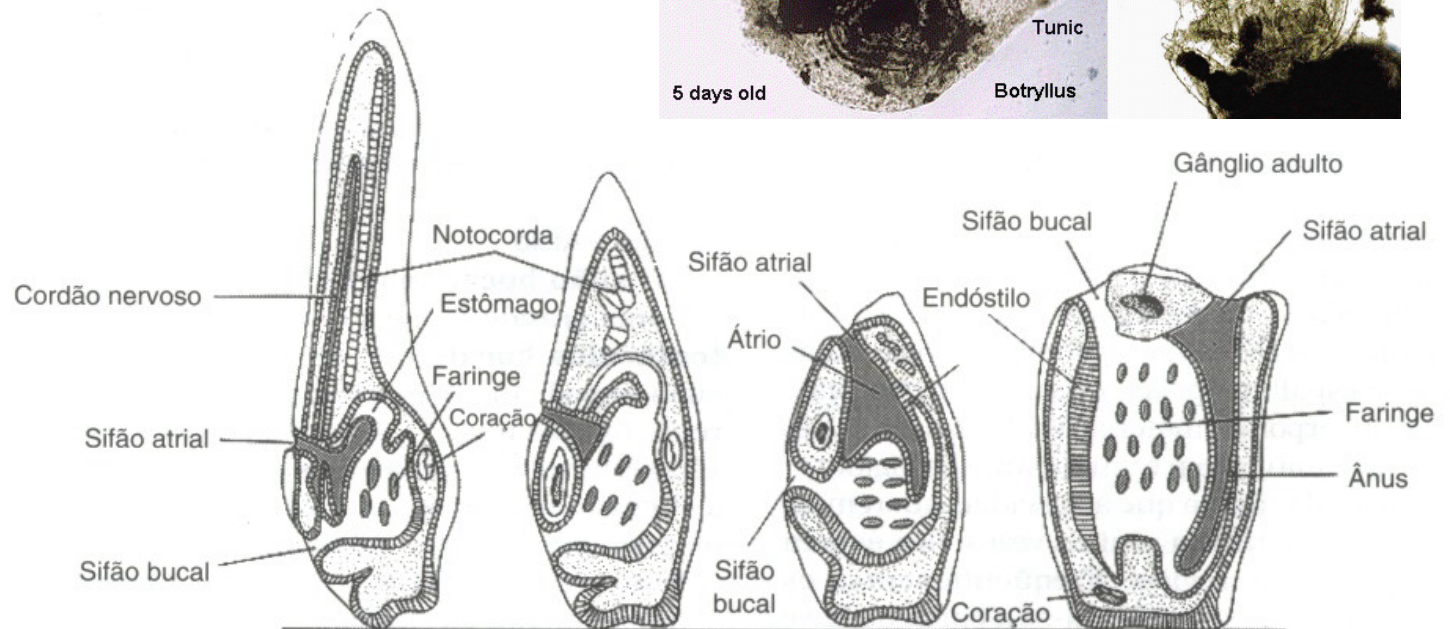
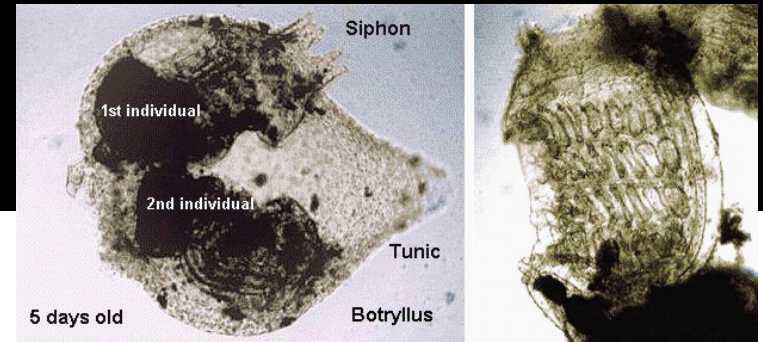
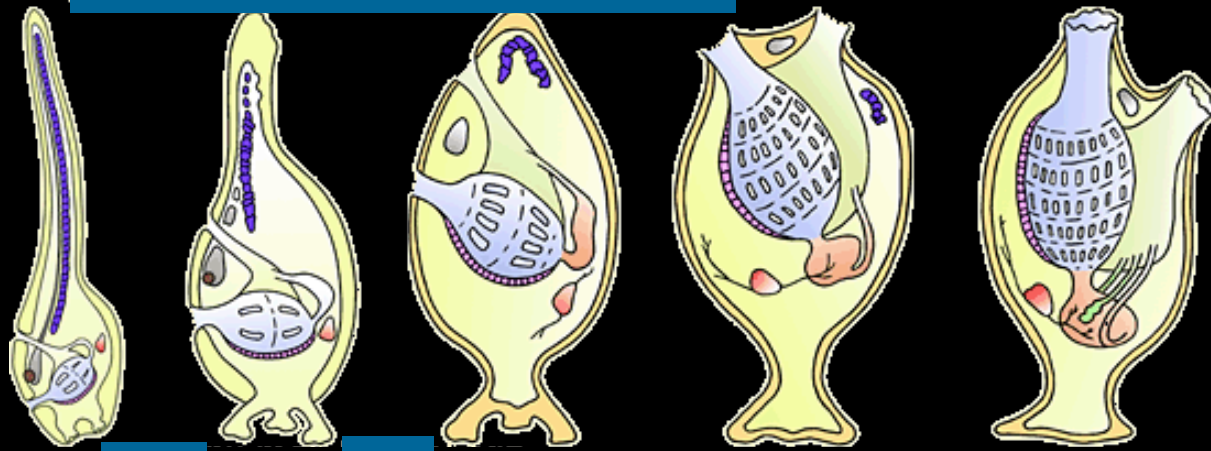


One day and two days eggs

Larva



Metamorfose

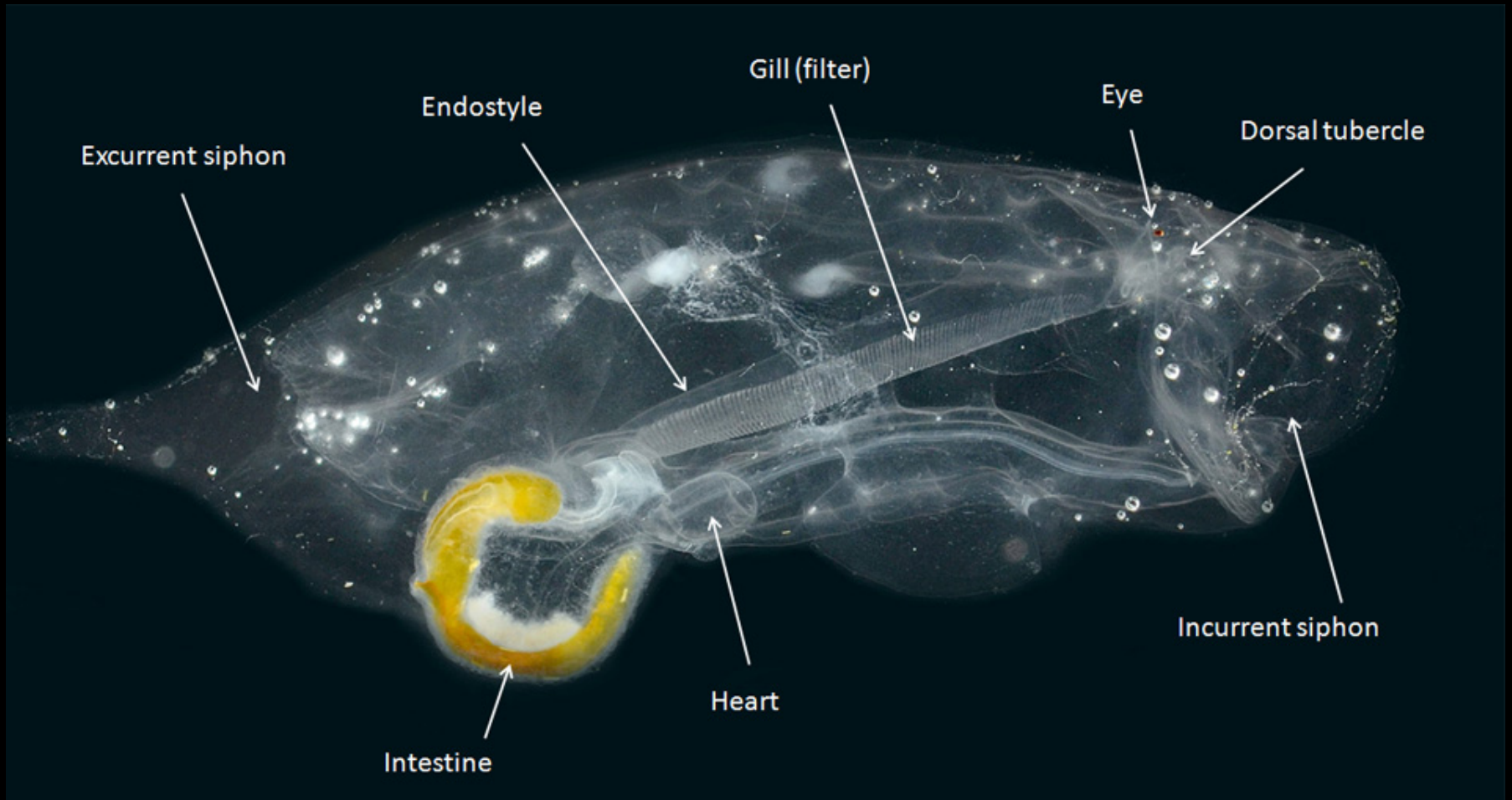


THALIACEA

Planctônicos, transparentes, propulsão a jato

Corrente alimentar ciliar

Ciclo de vida complexo, com estágio colonial



THALIACEA

Dolíolos e Salpas

Águas mais quentes

Colônia polimórfica assexuada, zoóides sexuais

Zoóides solitários

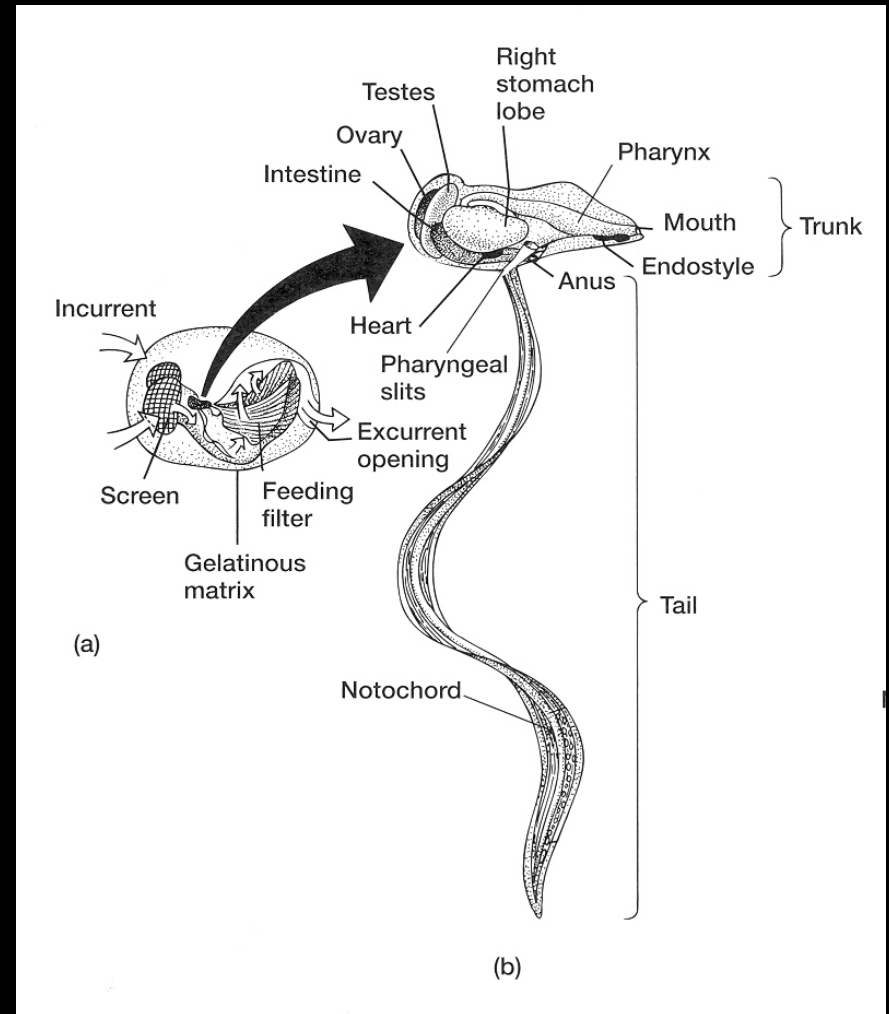
Faixas musculares circulares completas (dolíolos) ou incompletas (salpas)

Corrente alimentar ciliar (dolíolos) ou muscular (salpas)

Várias fendas faríngeas (dolíolos) ou apenas 2 fendas grandes



LARVACEA ou APPENDICULARIA

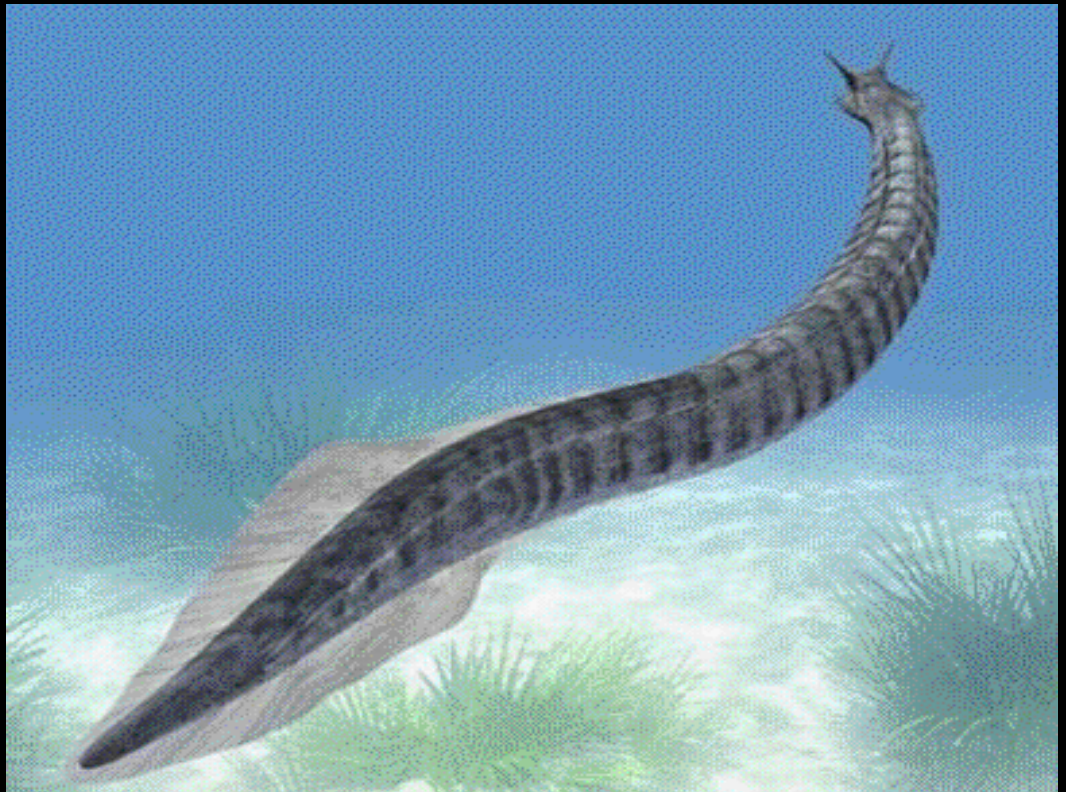


2 fendas faríngeas (espiráculos)
abrindo-se para o exterior

Cordados do Cambriano

Pikaia†

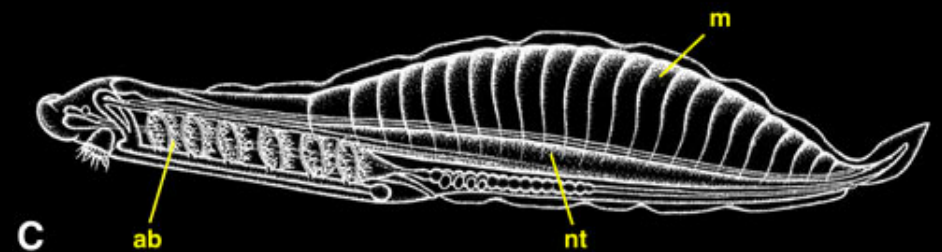
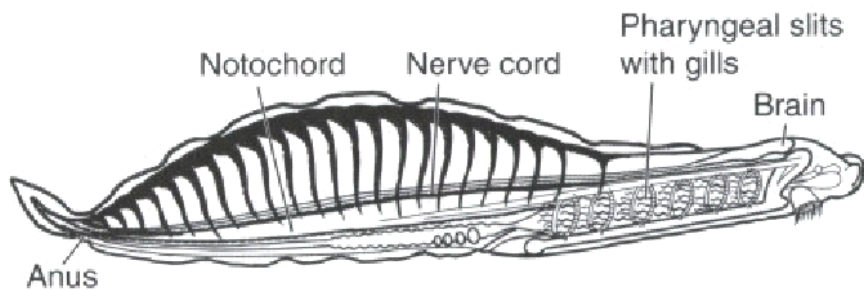
Burgess Shale, EUA

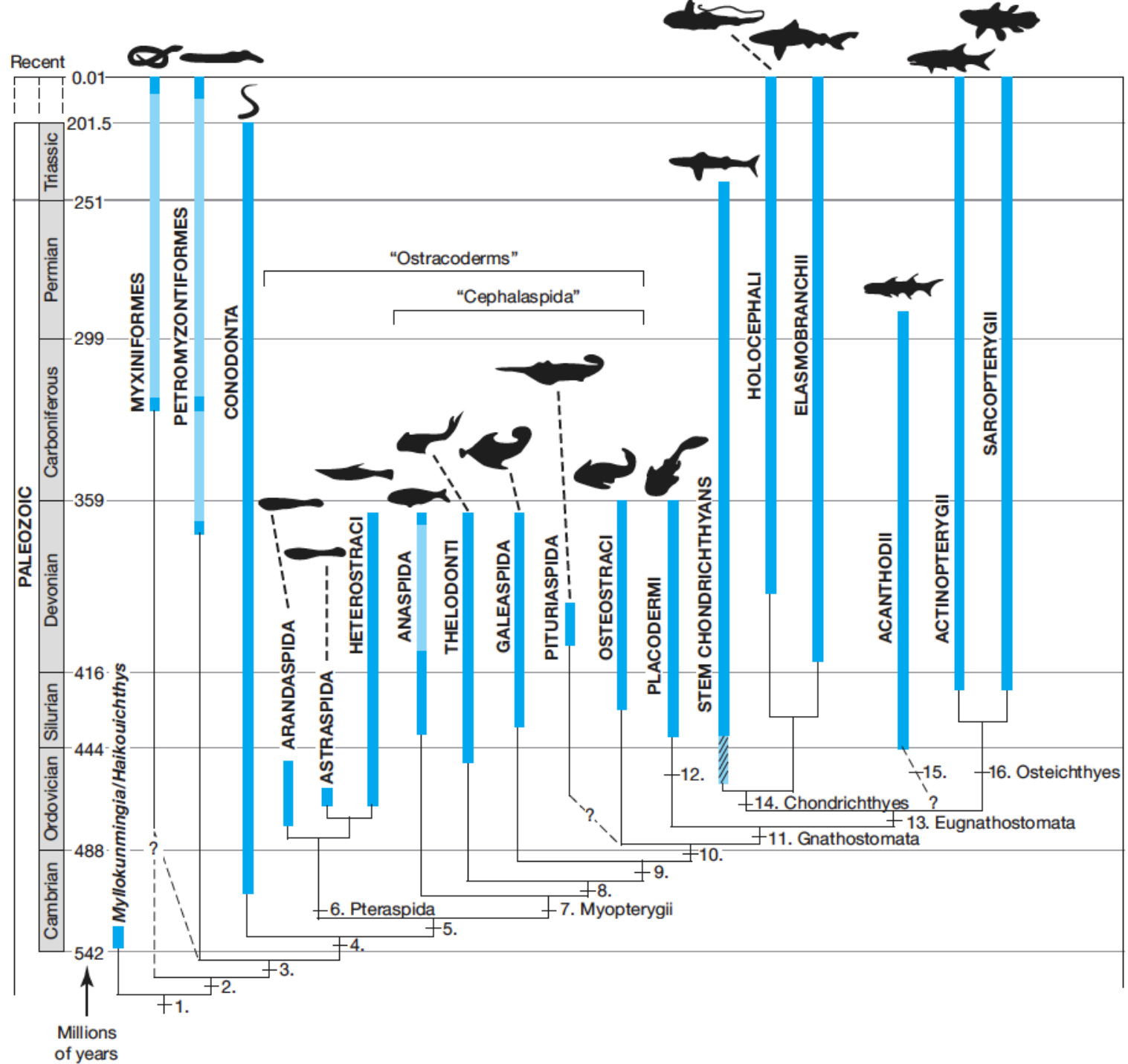


Cordados do Cambriano

Haikouella †

Chengjiang, China

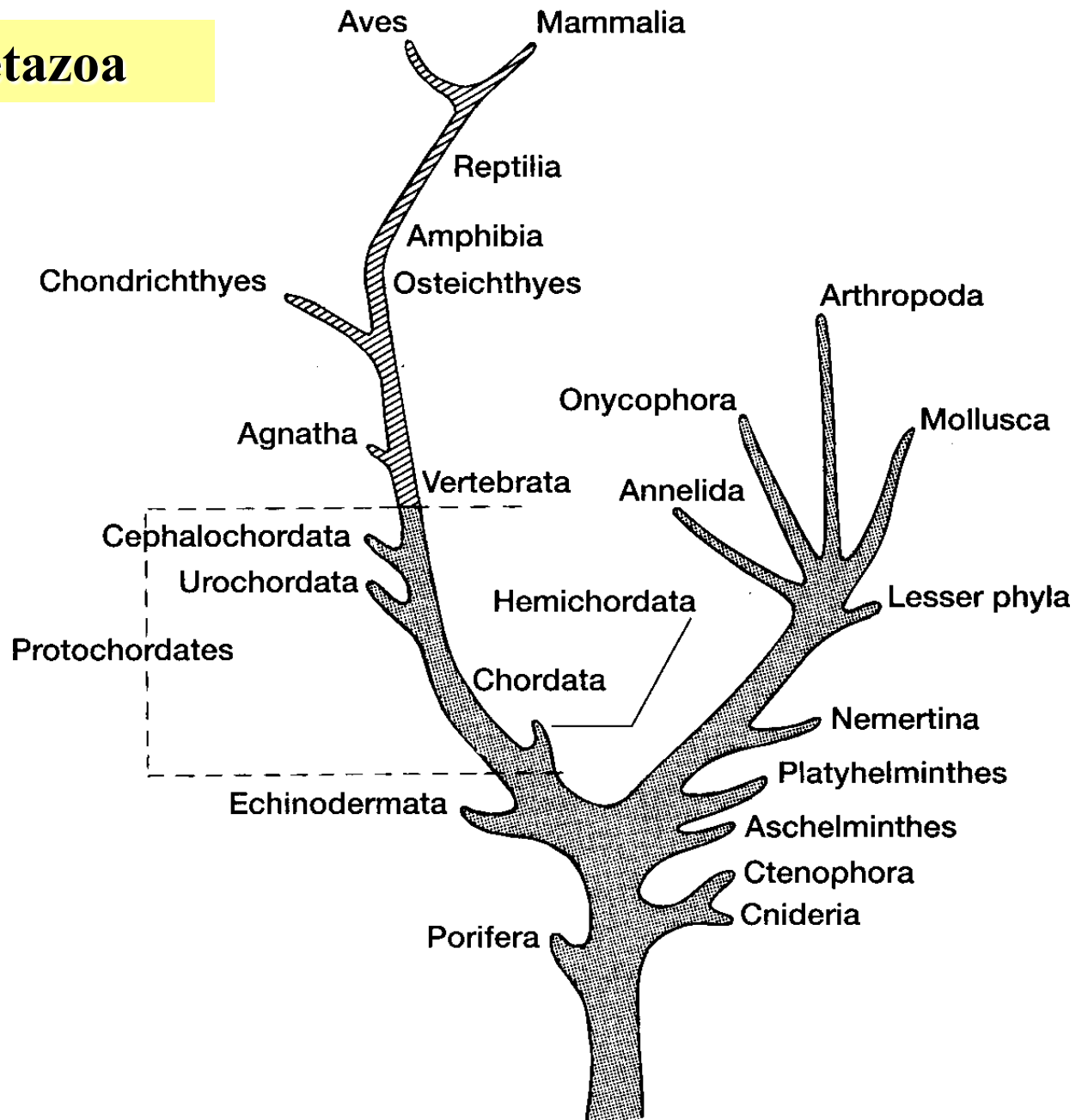


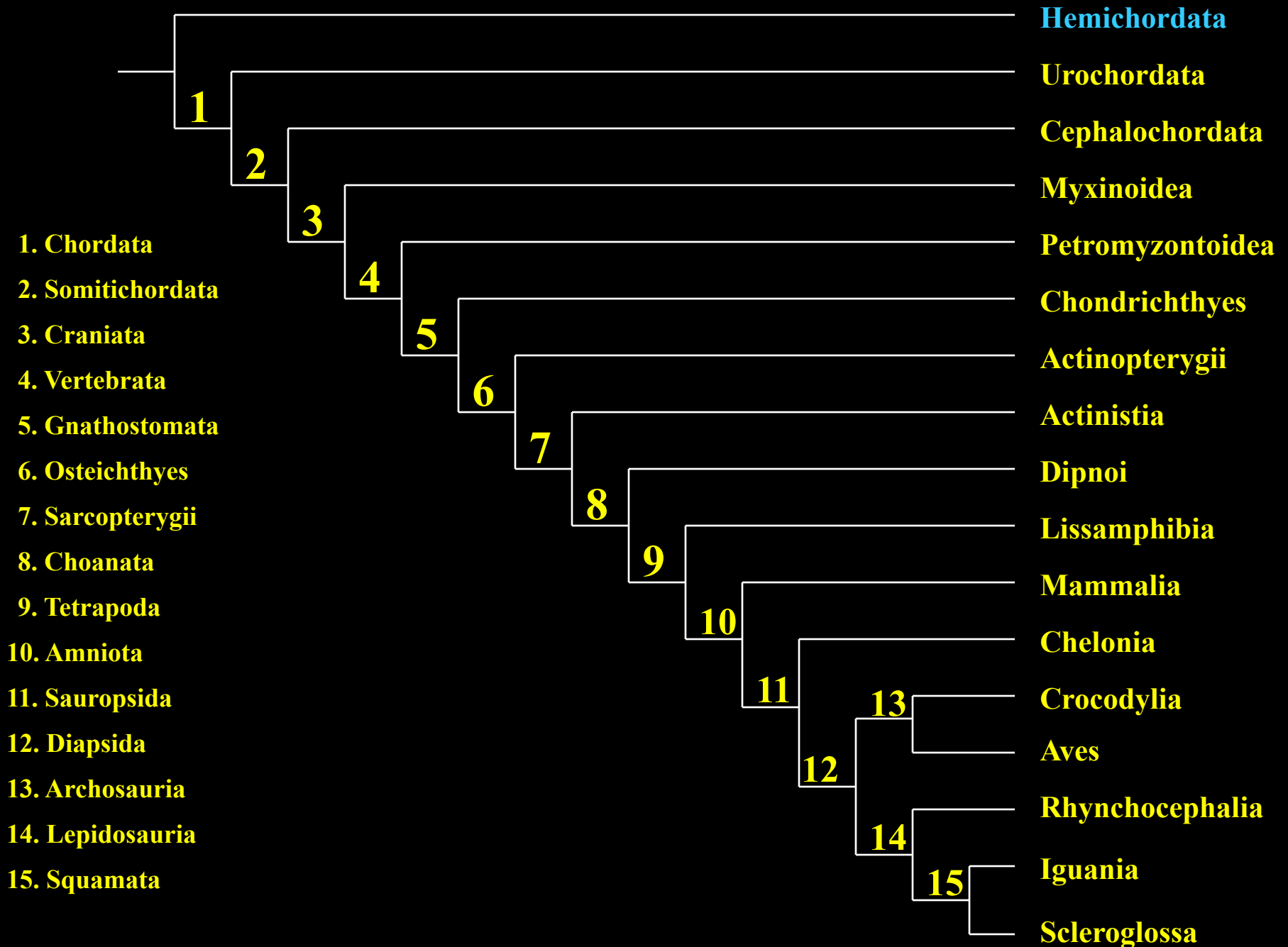


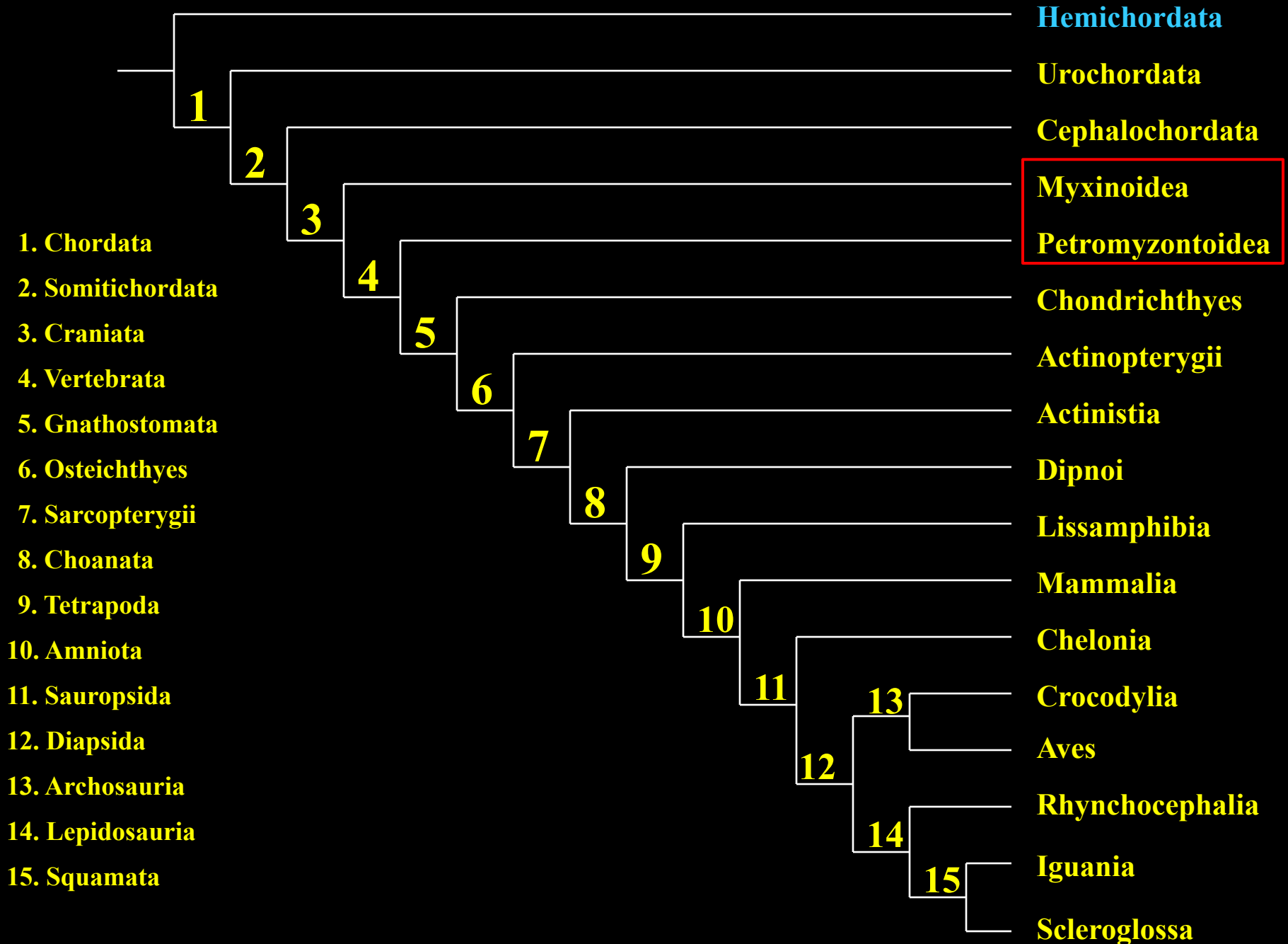
Origem dos Craniados e dos Vertebrados

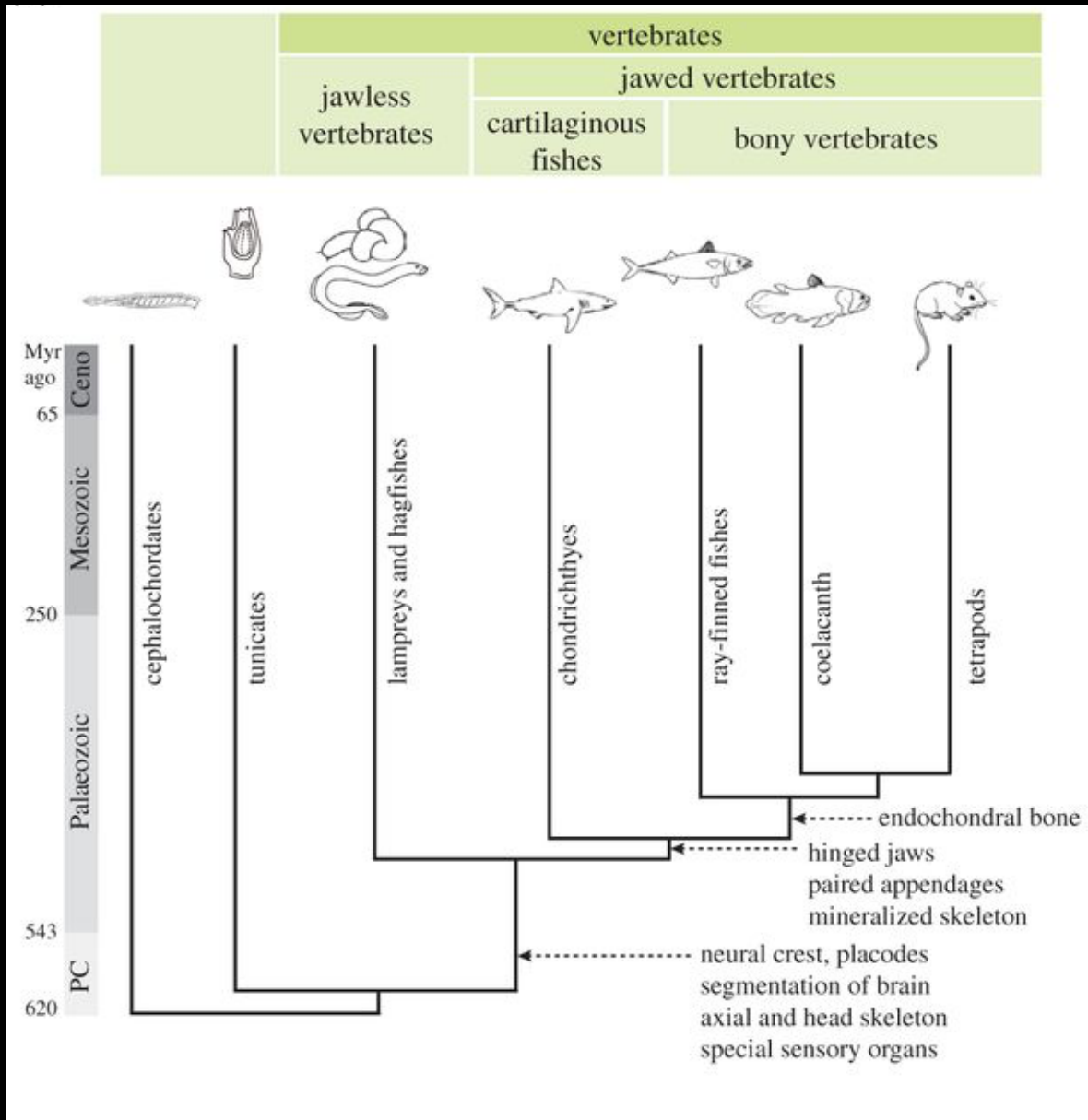


Filogenia de Metazoa





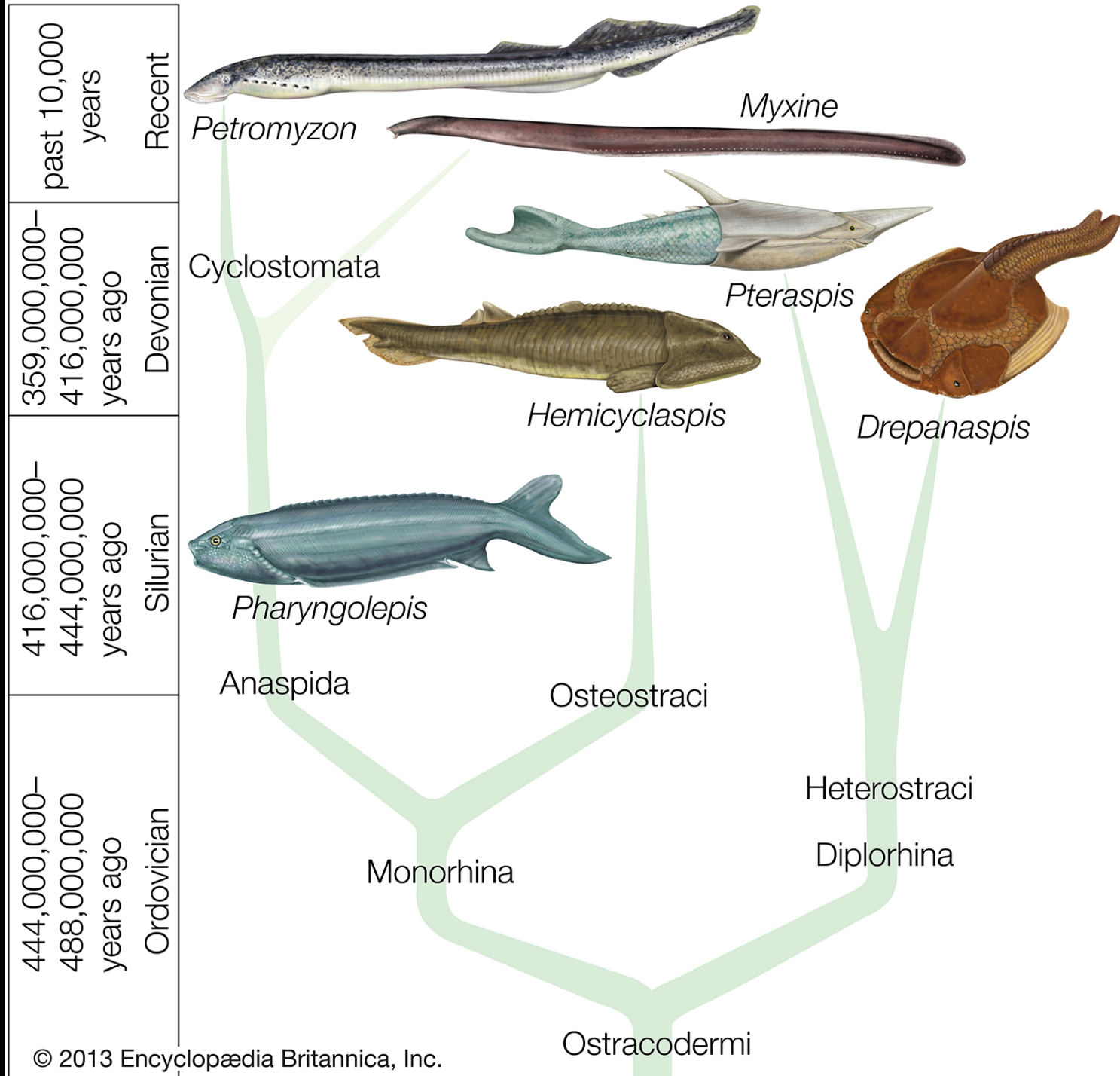




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Hemichordata

Urochordata

Cephalochordata

Craniata

probóscibe, colar e tronco
estomocorda

órgão da roda
tentáculos do velo

predadores
livre-natantes
pedomorfose

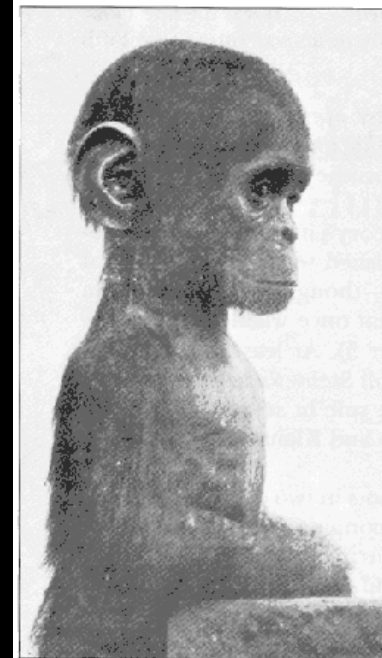
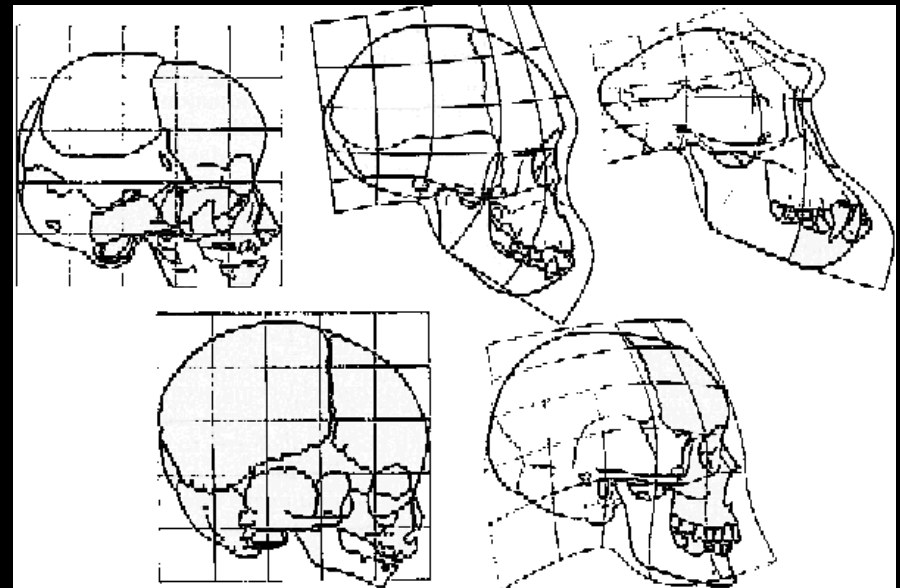
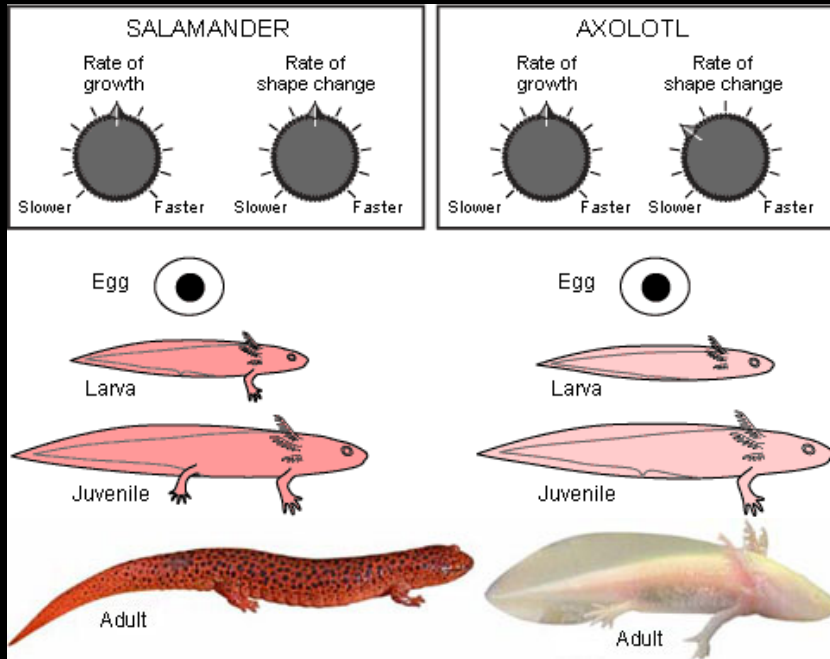
túnica

cordão nervoso em todo o corpo
notocorda em todo o corpo
cauda segmentada
ceco digestivo (= fígado)
sistema circulatório com aortas
substâncias branca e cinzenta

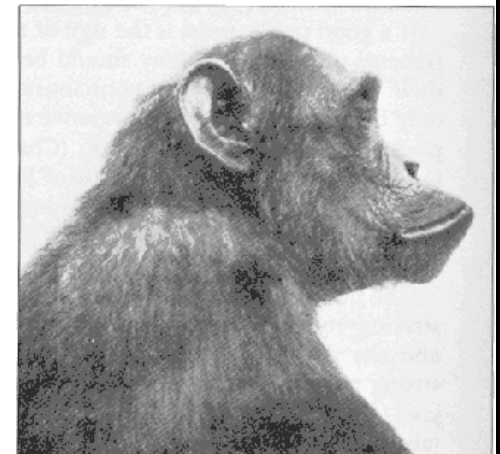
cordão nervoso na cauda da larva
notocorda na cauda da larva
cauda muscular pós-anal
endóstilo (= tireóide)

fendas na
faringe

Pedomorfose

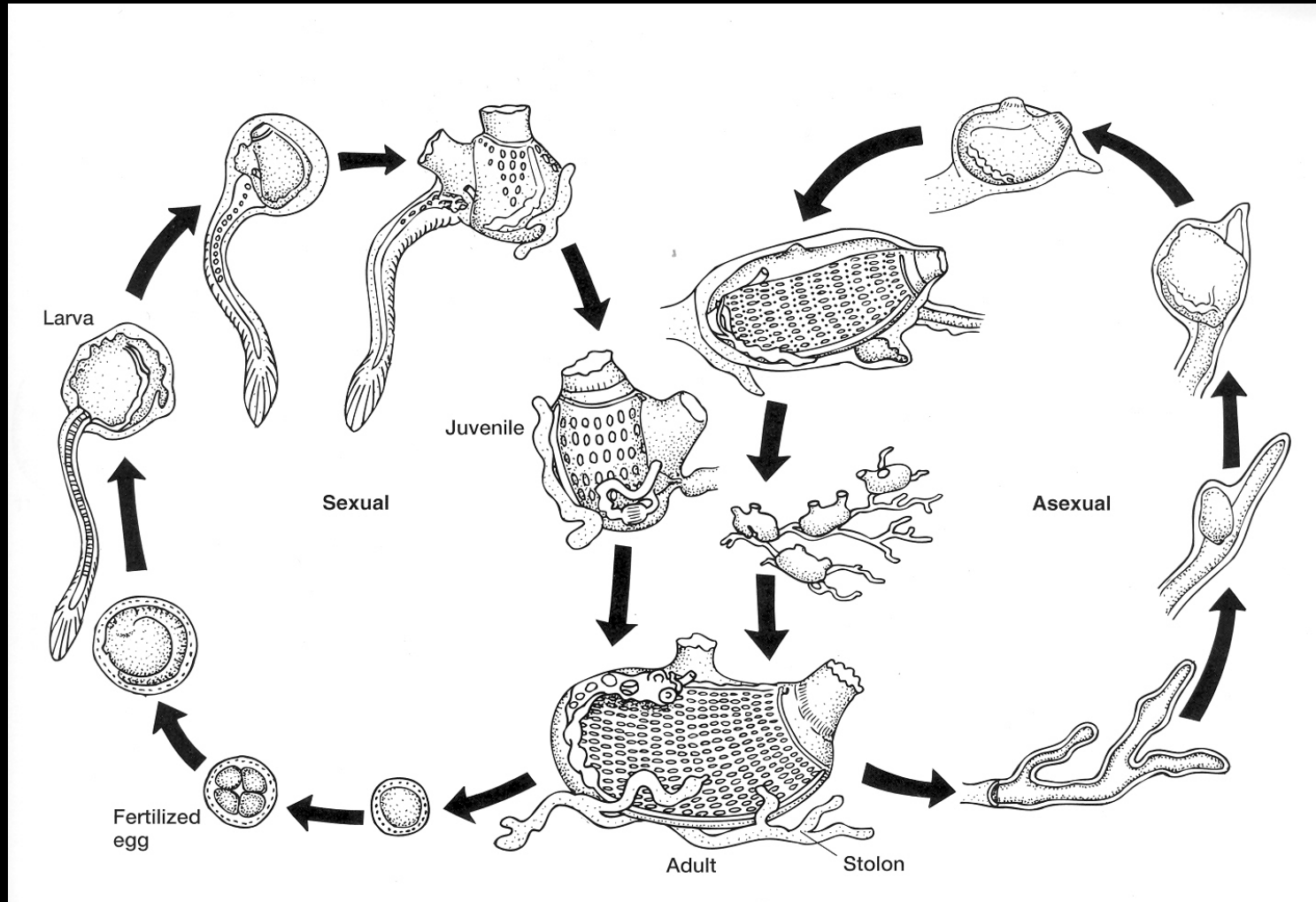


"Of all animal pictures known to me, this is the most manlike." (Naef, 1926)



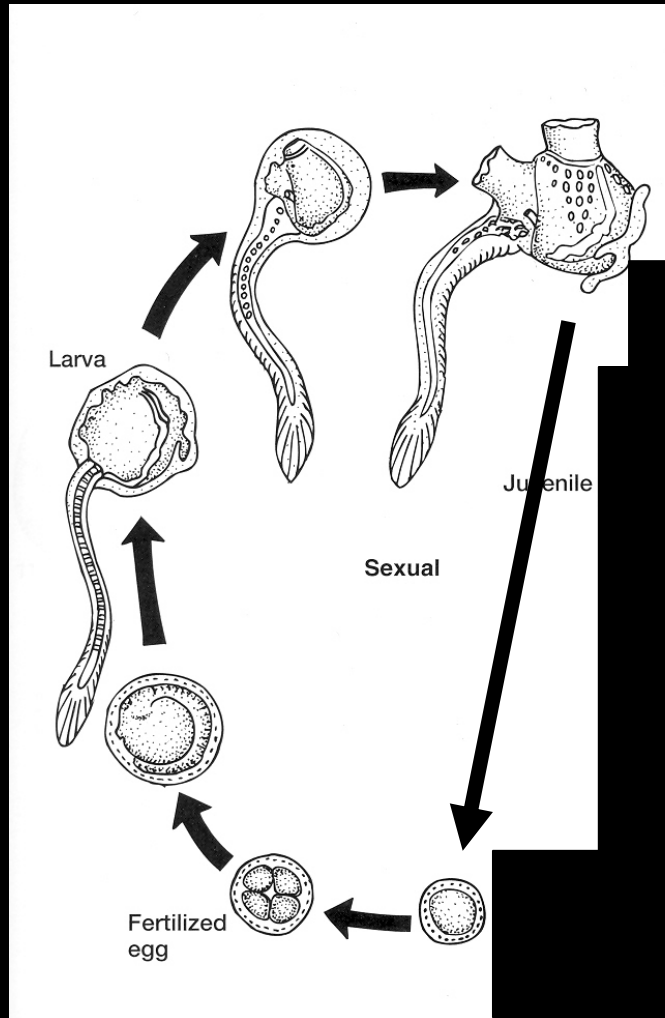
Reprodução Urochordata

Pedomorfose?



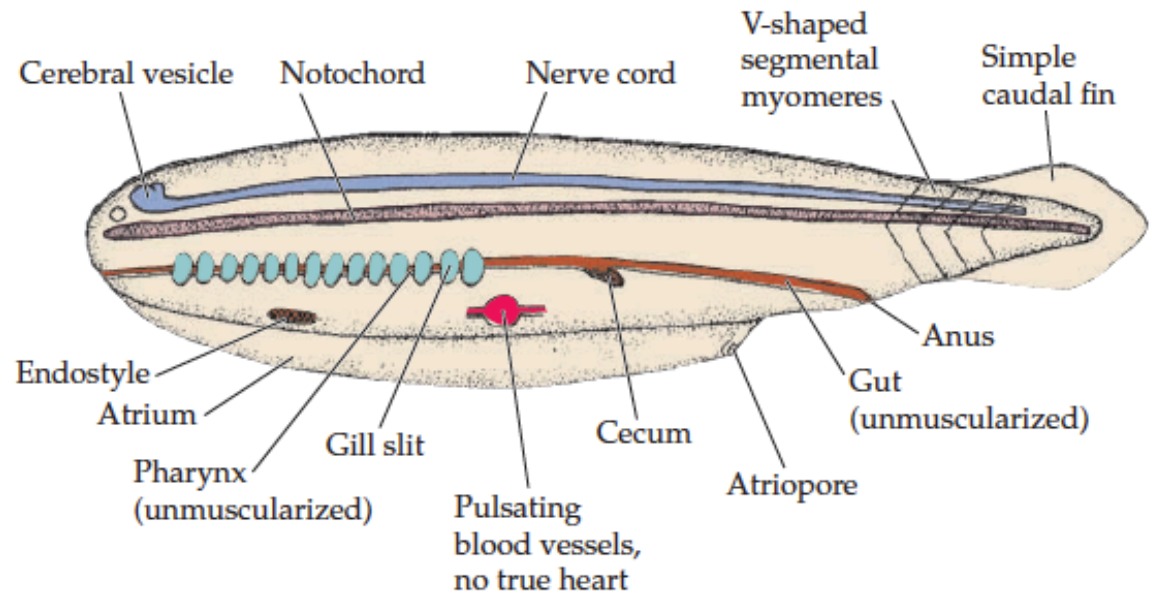
Reprodução Urochordata

Pedomorfose?

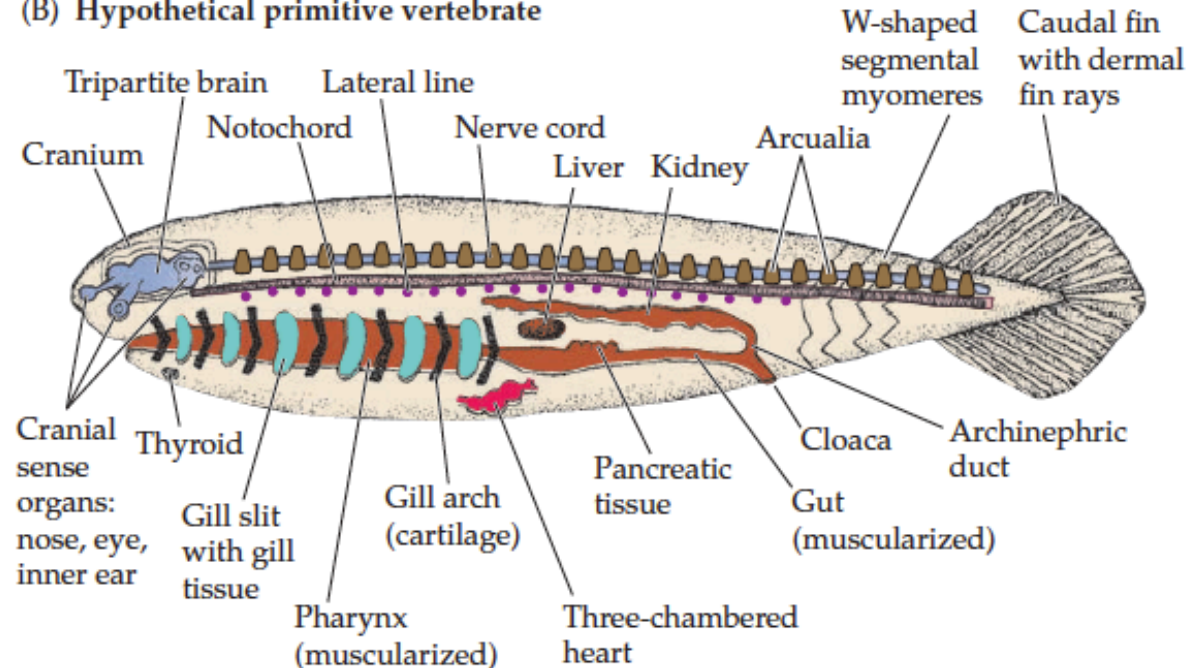


Estrutura Básica dos Vertebrados

(A) Amphioxus-like nonvertebrate chordate



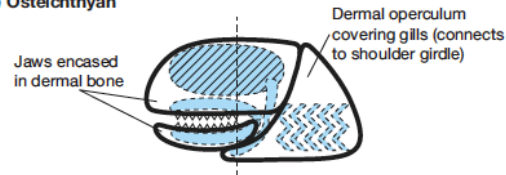
(B) Hypothetical primitive vertebrate



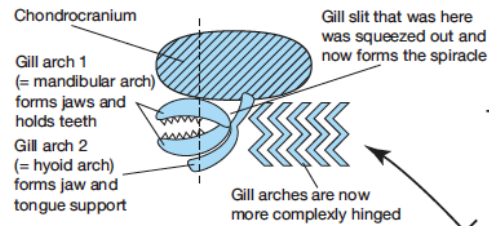
Crânio



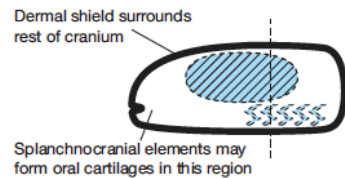
(e) Osteichthyan



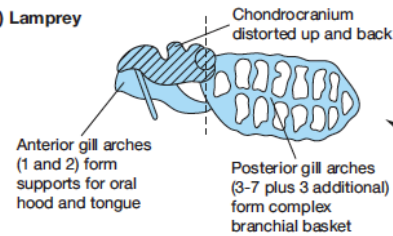
(d) Chondrichthyan



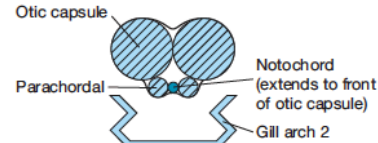
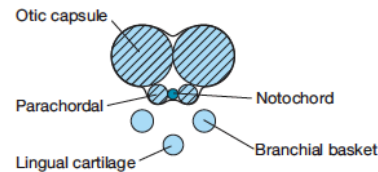
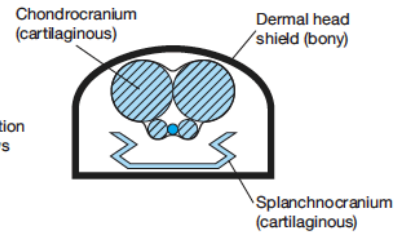
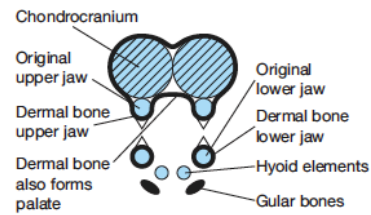
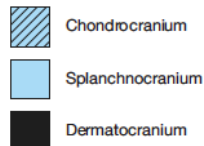
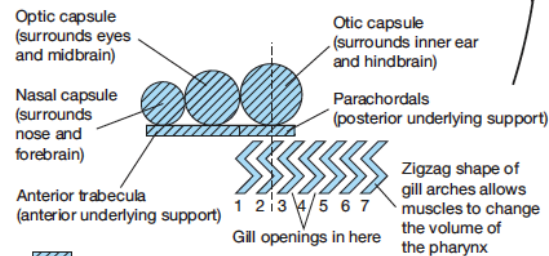
(c) Ostracoderm



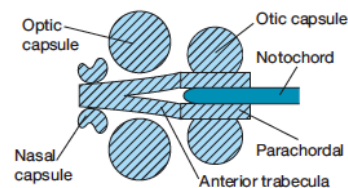
(b) Lamprey



(a) Basic vertebrate cranium

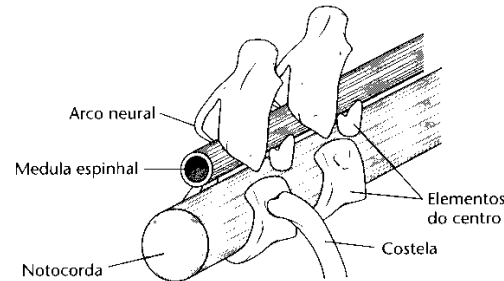


Ventral view of basic primitive vertebrate

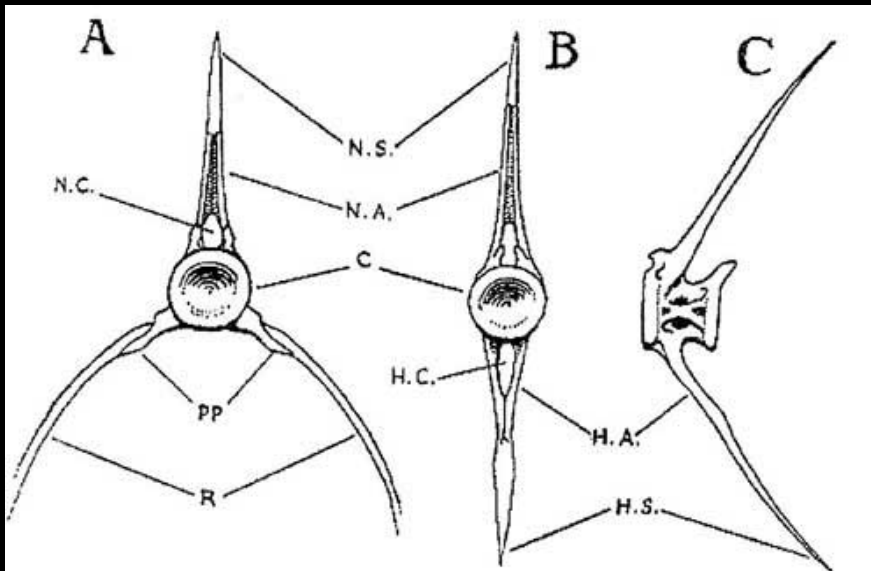
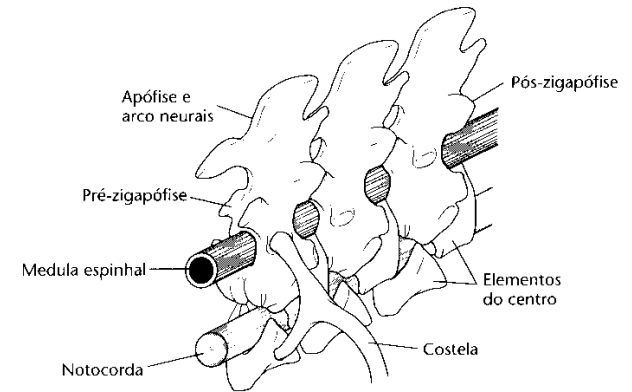


Vértebras e Costelas

Condição generalizada de um peixe



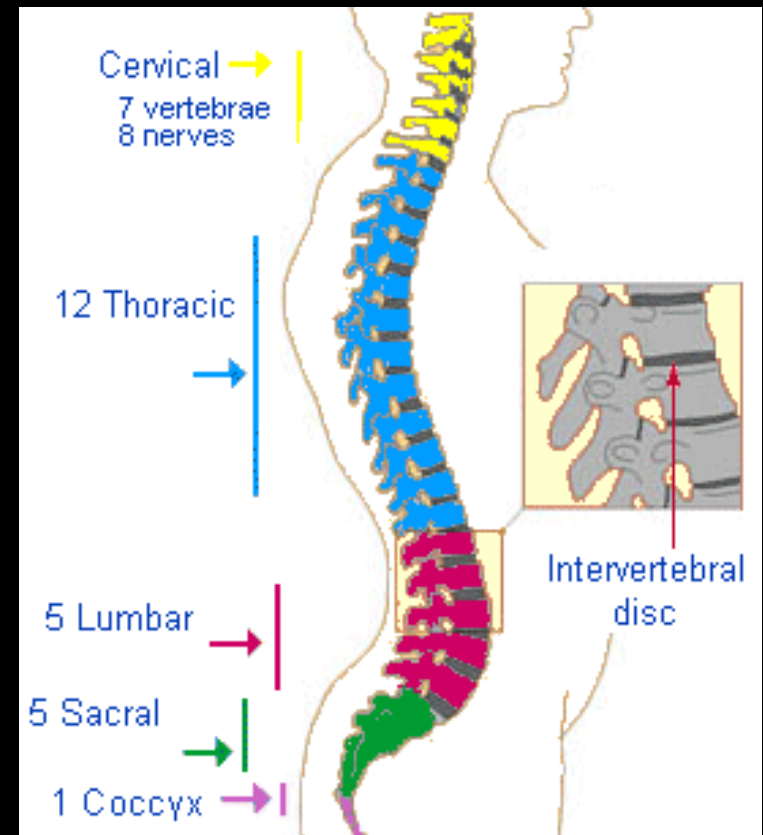
Condição generalizada de um tetrápode primitivo



VERTEBRAS

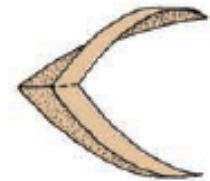
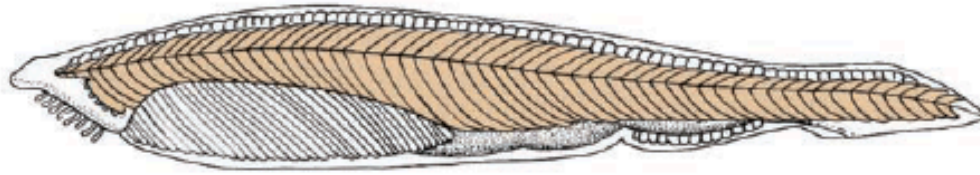
- A. Vértebra precaudal (tronco), vista frontal
- B. Vértebra caudal (cola), vista frontal
- C. Vértebra caudal, vista lateral

(C) cuerpo vertebral; (H.A) arco hemal; (H.C) canal hemal, a través del cual pasa la arteria principal; (H.S) espinha hemal; (N.A) arco neural; (N.C) canal neural, a través del cual pasa la médula espinhal; (N.S) espinha neural; (P.P) parapófisis; (R) costillas.



Miômeros

(A) Amphioxus



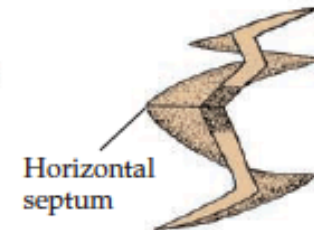
Myomeres
V-shaped

(B) Lamprey



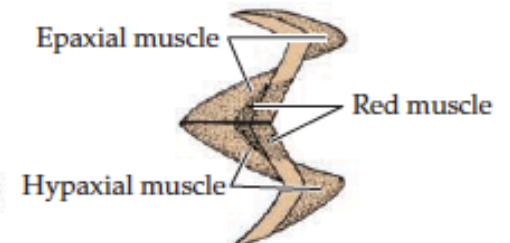
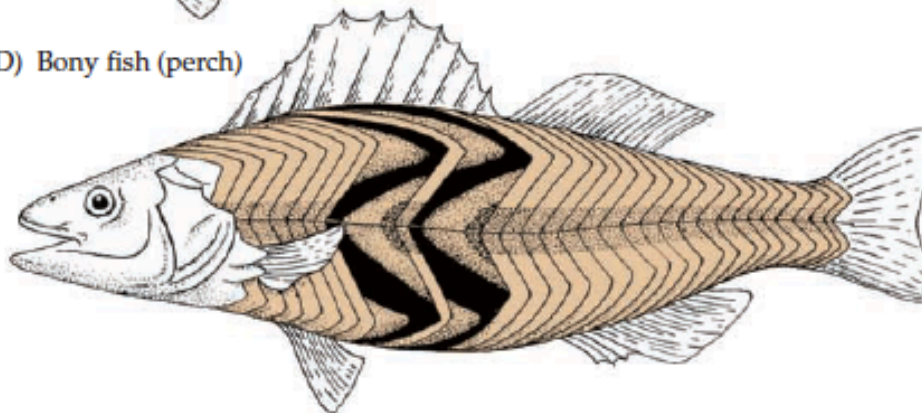
Myomeres
W-shaped

(C) Shark (dogfish)



Myomeres
more
complexly
folded

(D) Bony fish (perch)

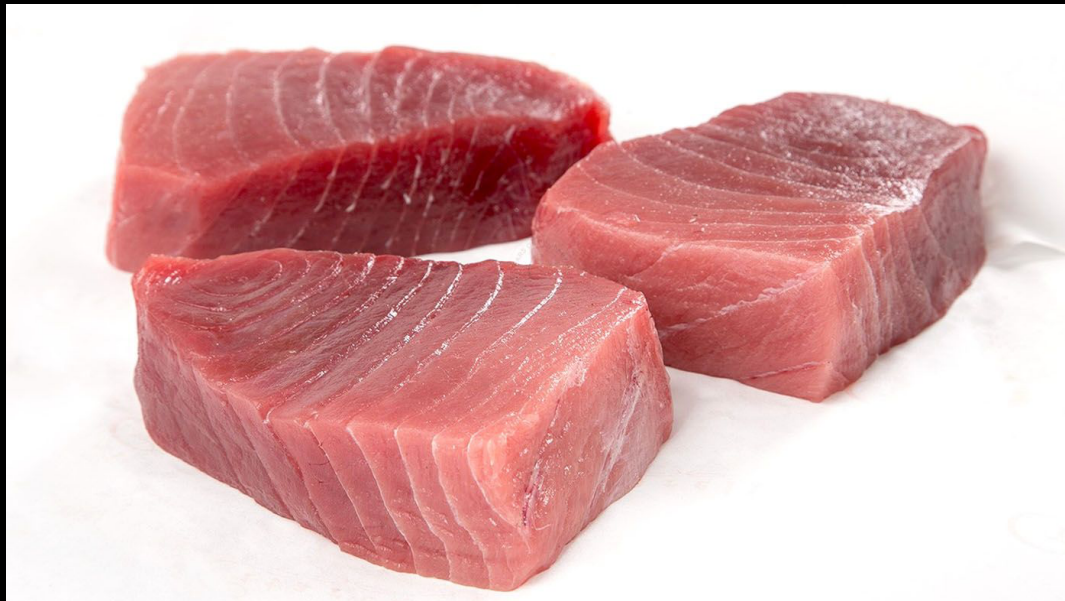


Epaxial muscle

Red muscle

Hypaxial muscle

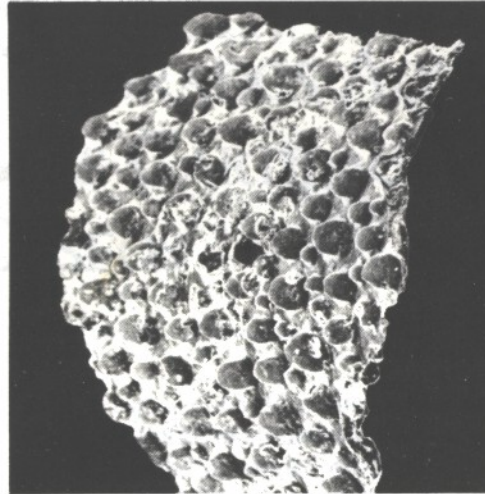
Miômeros



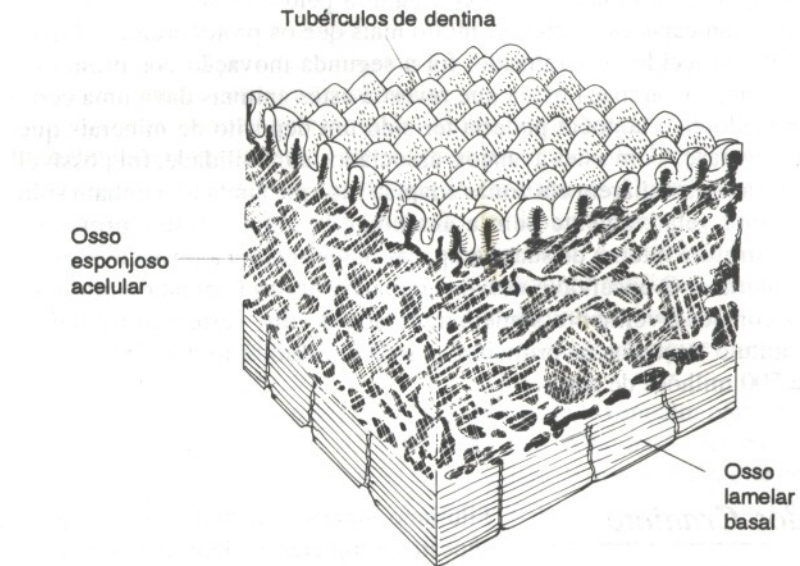
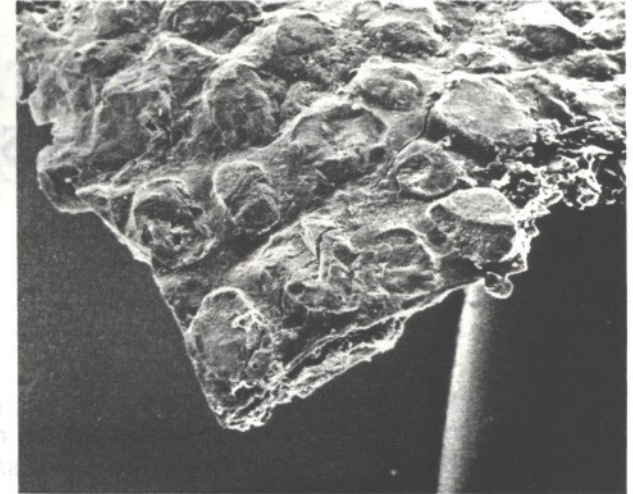
As Primeiras Evidências dos Vertebrados

Ordoviciano (480 m.a.)

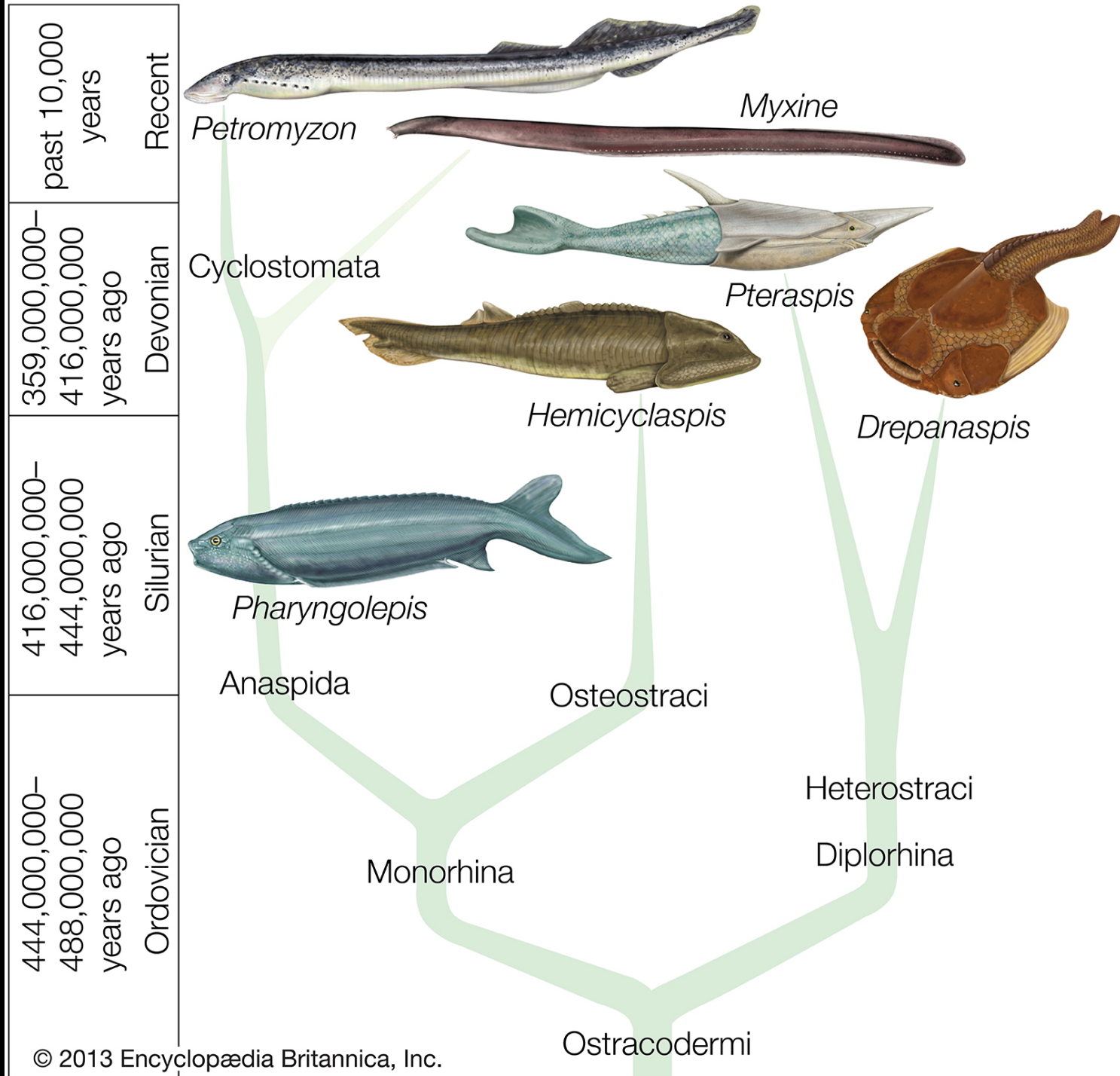
Fragmentos de armadura
dérmica dos Ostracodermes



(a)



(b)



Os Primeiros Vertebrados

Cambriano Inferior (~530 m.a.) - China

Myllokunmingia



3 cm de comprimento

Evidências de crânio e miômeros em W

Sem evidências de osso ou escamas mineralizadas

Evidências de suporte branquial cartilaginoso

Nadadeiras dorsal e ventrolaterais em forma de fita

Os Primeiros Vertebrados

Ordoviciano Inferior (~480 m.a.)

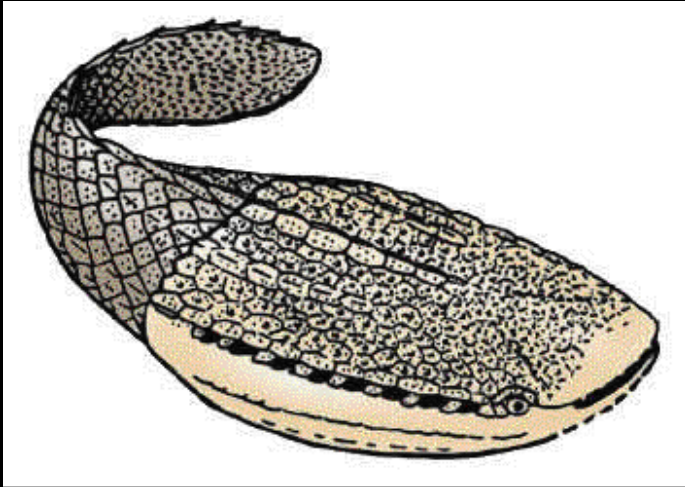
12-35 cm de comprimento

Armadura cefálica (placas ósseas poligonais)

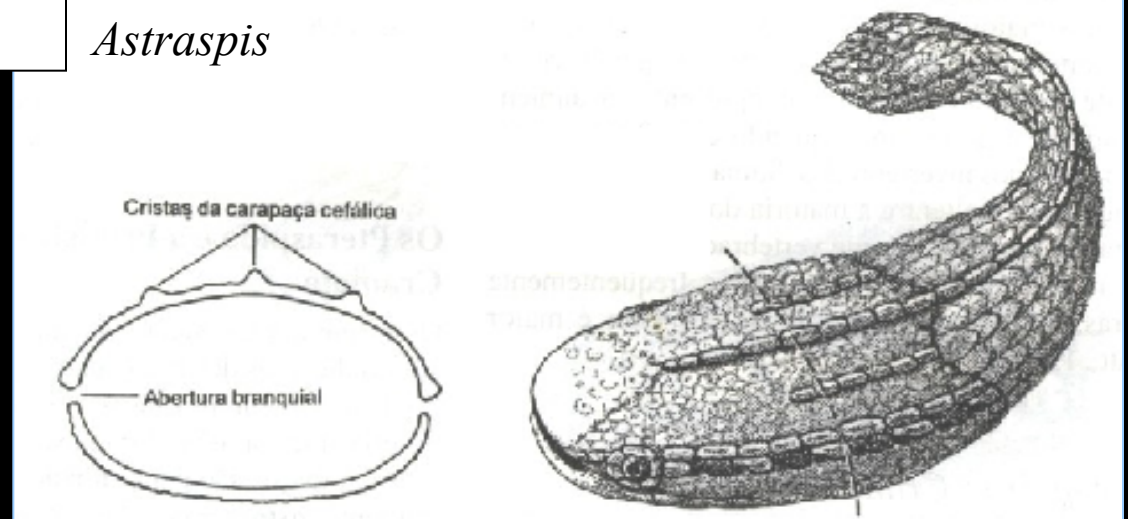
canais sensoriais

proteção em torno dos olhos

8 aberturas branquiais

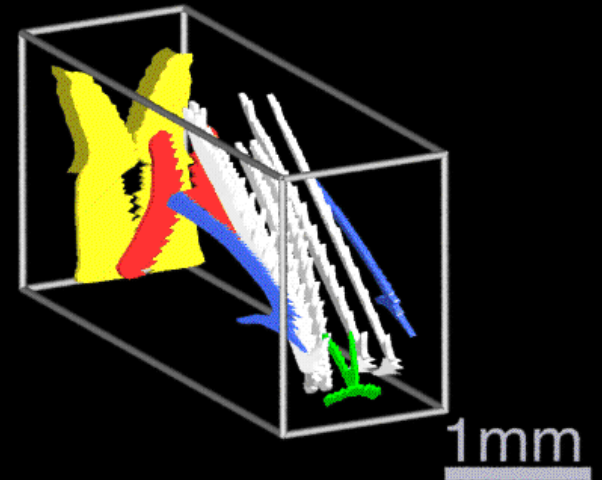
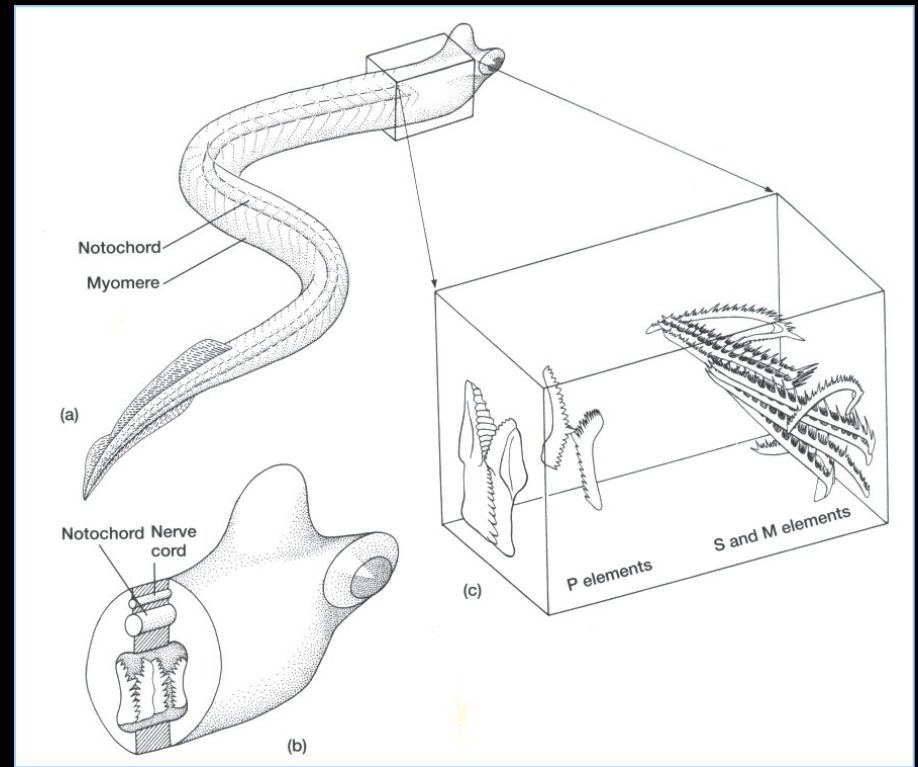
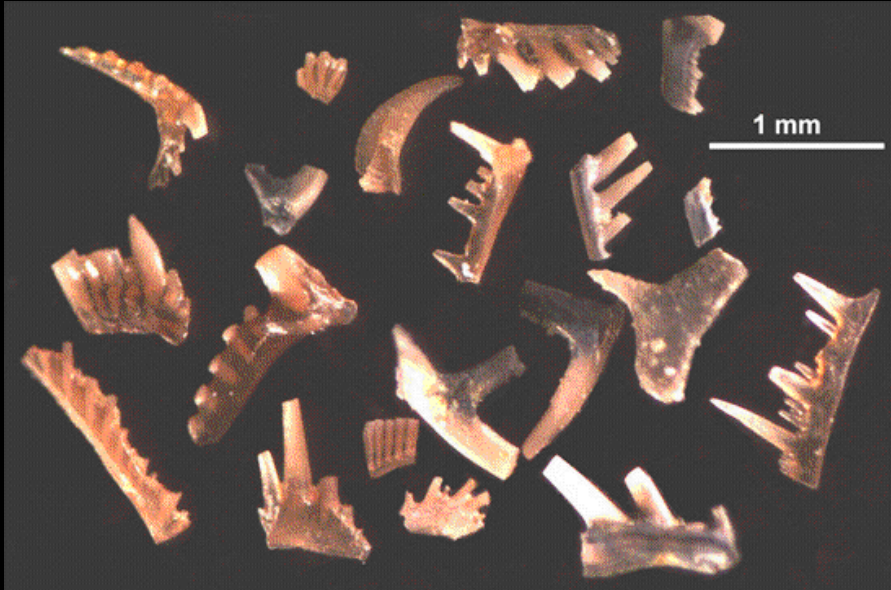


Astraspis



Conodontes

Cambriano Sup → Triássico Sup.

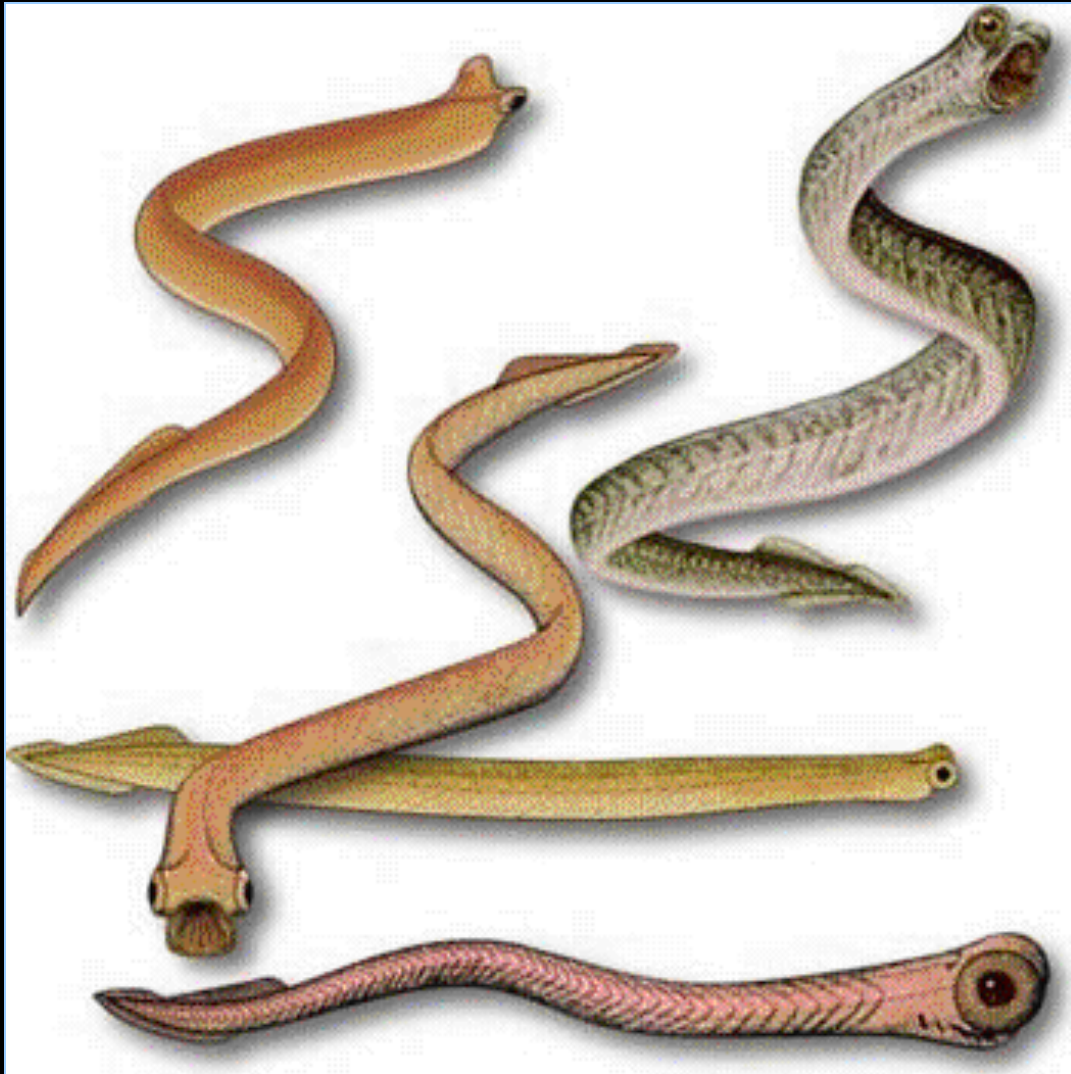


Apatita (carbonato e fosfato de cálcio)

Estrutura semelhante à dentina e ao esmalte

Conodontes

Cambriano Sup → Triássico Sup.

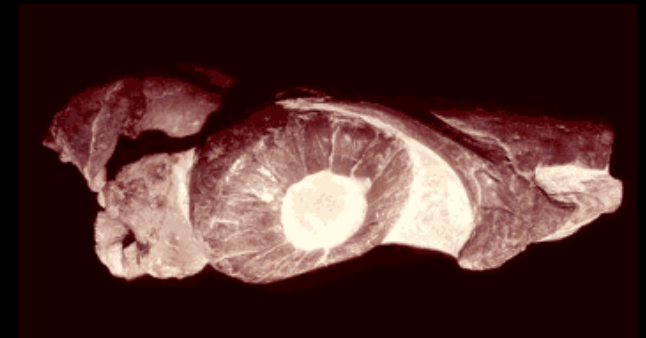


Evidências de notocorda, crânio, miômeros, raios de nadadeiras

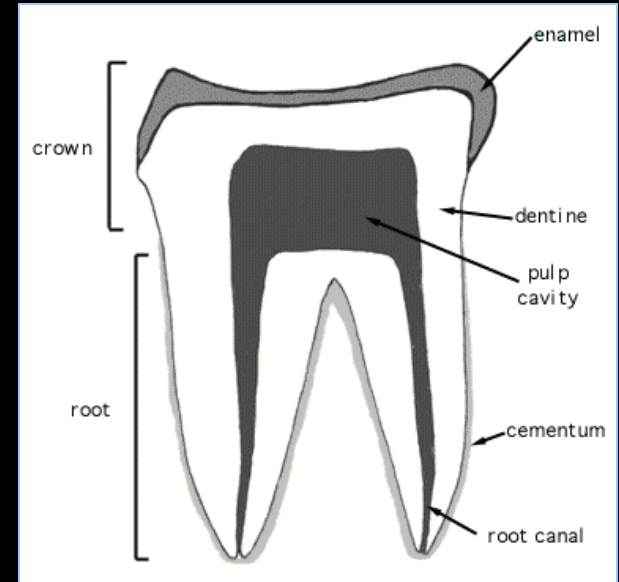
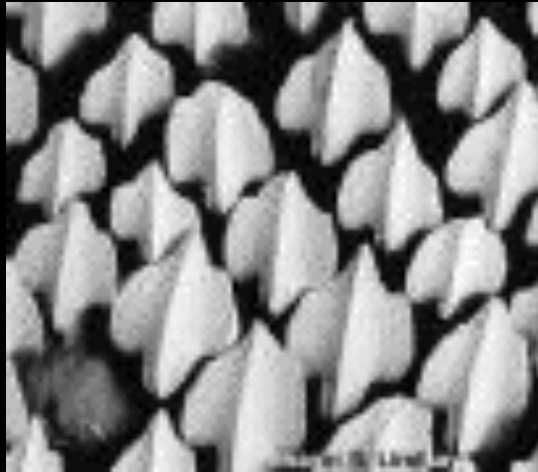
Grandes olhos protegidos por anéis escleróticos cartilaginosos (evid. de m. oculares extrínsecos)

Sem evidências de fendas faríngeas

40 cm (respiração cutânea?)



Primeiros Tecidos Mineralizados



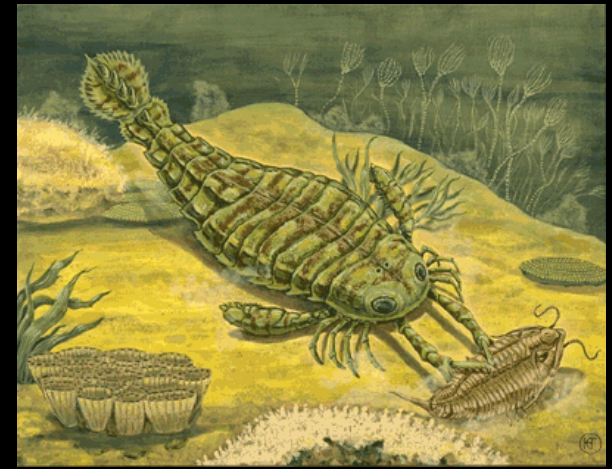
Odontódios

Esmalte (enamelóide) e **dentina**: dentes de vertebrados atuais e armadura dérmica dos ostracodermes

condição primitiva: odontódios no tegumento (dentina + esmalte)

homologias: dentes, escamas dos tubarões, armadura de ostracodermes

Origem do Osso e dos Tecidos Mineralizados



Osso: exclusivo de vertebrados

condição primitiva: acelular (celular em Osteostraci e Gnathostomata)

vantagens evolutivas:

- defesa (euripterídeos?)
- dentina com sistemas de poros e tubérculos (sensorial?)
- revestimento protetor e isolante em torno de eletorreceptores (predação)
- reserva de Ca e P (raro no ambiente): deposição e mobilização de Ca^{++} e PO_4^{--}
- hidroxiapatita: mais resistente à acidez do sangue do que CaCO_3 (moluscos)

metabolismo anaeróbico $\rightarrow$ ácido láctico $\rightarrow$ $\downarrow$ pH do sangue

Origem no Mar ou na Água Doce ?

Abundantes no mar e na água doce

pré-adaptação

Água doce:

- o **rim** elimina rapidamente o excesso de água que entra no corpo por osmose

Marinha:

- primeiros fósseis no ambiente marinho
- todos os cordados não-vertebrados e os demais deuterostômios são marinhos
[líquidos corporais] = [água do mar] (feiticeiras atuais)